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ERRATA

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Page 34 line 16 from bottom *for* **Corryllis** *read* **Coryllis.**

,, 37 ,, 8 *for* **ambigus** *read* **ambiguus.**

,, 156 in the heading: *delete* letters R. O.

,, 158 line 28. *for* sports *read* sport.

,, 158 line 30. *for* Ridowing *read* Pidoung.

,, 162 In penultimate line of second paragraph
for Telugu *read* Tamil.

,, 185 line 29 from bottom *for* **Tarmix** *read* **Turnix.**

,, 207 ,, 9 ,, ,, *for* **canante** *read* **canente.**

,, 320 ,, 7 *for* **micropterum** *read* **micropternus.**

,, 382 ,, 9 from bottom *for* **maclolophus** *read* **macholophus.**

,, 383 ,, 7 ,, ,, *for* **Ægithinia** *read* **Ægithina.**

,, 384 ,, 18 ,, ,, *for* **Saxicolor** *read* **Saxicola.**

,, 384 lines 4 & 10 ,, *for* **Œnathe** *read* **Œnanthe.**

,, 386 line 23 *for* **Rhidipura** *read* **Rhipidura.**

,, 388 ,, 31 *for* **juncidas** *read* **juncidis.**

,, 400 ,, 2 from bottom *for* **Cotunnix** *read* **Coturnix.**

,, 402 ,, 16 *for* **Sarciornis** *read* **Sarciophorus.**

,, 403 ,, 8 from bottom *for* **Xenorynchus** *read* **Xenorhynchus.**

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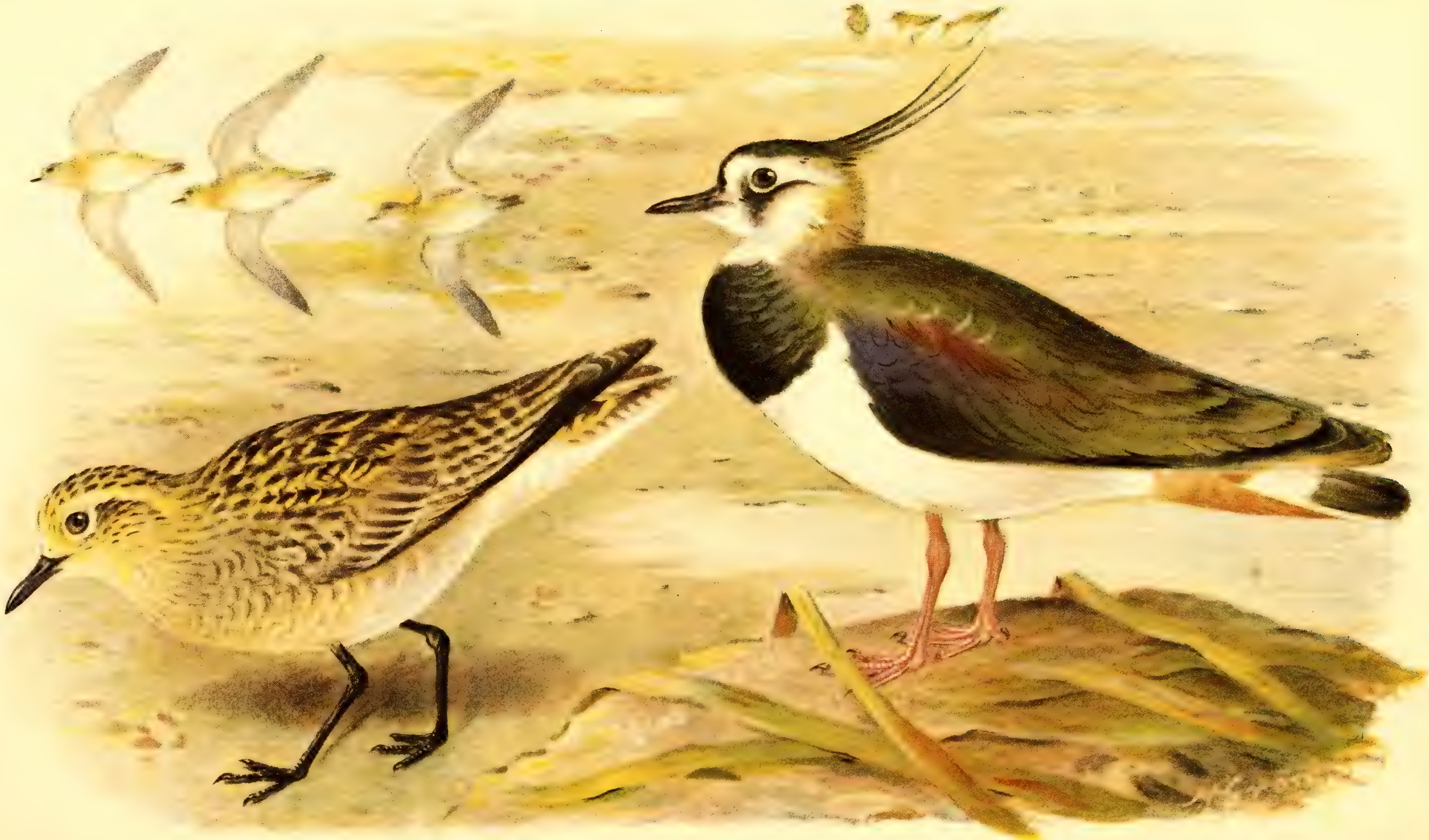

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THE EASTERN GOLDEN PLOVER. 2/5.
Pluvialis dominicus fulvus.

THE LAPWING. 2/5.
Vanellus vanellus.

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THE GAME BIRDS OF THE INDIAN EMPIRE.

BY

E. C. STUART BAKER, F.Z.S., F.L.S., M.B.O.U., H.F.A.O.U.

VOL. V.

THE WADERS AND OTHER SEMI-SPORTING BIRDS.

PART XIV

(With a colour plate)

(Continued from page 876 of Vol. XXXIV.)

GENUS : PLUVIALIS.

Pluvialis Brisson, Orn. i, p. 46 ; Vol. v, p. 42, 1760.

Type by taut. *Charadrius apricarius* Linn.

Superficially very like the genus *Squatarola*, without a hind toe. In this genus the bill is slender and short, with the dertrum but slightly swollen ; the nostrils are linear and are placed in a groove which extends about two-thirds the length of the upper mandible ; the wings are pointed, the first primary longest, the outer secondaries short and inner long and pointed ; tail short and rounded ; tarsi reticulated all round with hexagonal scales ; outer and middle toes connected by a short web at their bases ; the sexes are alike and there is a distinct breeding plumage.

Key to Species.

A.	Axillaries pure white	...	... *P. apricarius.*
B.	Axillaries greyish-brown	...	... *P. dominicus.*

PLUVIALIS APRICARIUS.

In October, 1921, Mrs. A. C. Meinertzhagen separated the bird breeding in the British Isles under the name of *C. a.* ***oreophilus*** on account of certain minor differences in the breeding plumage. As all our Indian specimens in the British Museum are in non-breeding plumage, it is impossible to say to which race they belong, until more material is available. Under the circumstances I only include the more Eastern form, which is the one we should expect to see.

PLUVIALIS APRICARIUS APRICARIUS.

The Golden Plover.

Charadrius apricarius—Linn., Syst. Nat. 10th ed., i, p. 150 (1758) (Oeland, Sweden).

Charadrius pluvialis.—Blanf. and Oates. iv, 235.

Vernacular Names.—Chota Battan (Hind.)

Description : *Breeding Plumage.*—Forehead and lores yellowish-white, spotted with brown ; short supercilia yellowish ; whole upper plumage blackish-brown, each feather with a golden tip and spots along the edges, giving the whole a spangled gold appearance ; primaries blackish, the shafts brown with a white patch near the tip, this white extending on to the inner webs in the innermost ; in freshly-moulted birds there is a fine edging of white to the tips ; sides of the head mottled white, brown and gold ; chin white ; throat, fore-neck and vent black, surrounded by a narrow broken white band ; flanks like the back ; axillaries and under tail-coverts white, the latter spangled with gold and brown except in the centre.

Colours of soft parts.—Iris brown ; bill, legs and feet black.

Measurements.—Wing 181 to 194 mm. ; tail 60 to 75 mm. ; tarsus 37 to 42 mm. ; culmen 21 to 26 mm.

In Winter the upper parts are sometimes rather duller ; the chin and throat are white, faintly streaked darker, the breast is mottled gold and brown, the gold disappearing on the lower breast, which with the flanks are white with brown bars ; centre of abdomen, vent and under tail-coverts white, the latter tipped and barred on the lateral feathers with gold and brown.

In many specimens the gold on the breast is replaced by brown-grey.

Young birds are like the adult in non-breeding dress but have the underparts darker, the breast more marked with brown and the posterior flanks and abdomen barred with brown and marked faintly with pale gold.

Nestling in down.—Mottled gold and black above, except on the hind-neck, which is white or nearly so ; below dull white.

Distribution.—Europe, Northern Africa, Western Asia to Lake Baikal, migrating South to Tropical Africa and India East to Assam.

To India the Golden Plover is only a rare visitor, occurring occasionally between October and March. Specimens have been shot at Quador and Baluchistan, Karachi, Lehwan and, again near Lucknow, a single specimen was obtained by Capt. Hanna, whilst, finally, I myself shot two specimens in Dibrugarh in Assam. This is the only occasion it has been found so far East, practically all the other records of its occurrence being confined to the North-West of India.

Nidification.—This Plover breeds over the greater part of Northern Europe as far East as Western Siberia, the Yennessei and Lake Baikal where throughout the extreme eastern portion of its habitat, particularly to the east of the Ural Mountains, it may be found breeding in company with the next bird, the Eastern Golden Plover, many of the so-called eggs of the latter bird offered for sale being really those of the former. In the southern portions of its breeding range the Golden Plover commences to lay about the 20th of April and on into the middle of May, whilst in the northern portions fresh eggs may be found up to the third week in June. The nest is either a natural hollow or one scraped out by the birds themselves and is well-lined with grass, heather or whatever vegetable material may be obtainable in the immediate vicinity. Rarely the nest is placed in no hollow but merely consists of beaten herbage matted together and lined with a few leaves and a little grass. It is almost invariably well concealed and extremely difficult to find, for it is almost impossible to catch the bird on the nest unless the eggs are nearly on the point of being hatched. I have, however, on more than one occasion, found them by making a man walk across a likely area, keeping my field-glasses fixed about a hundred yards ahead of him, when sometimes I was lucky enough to spot the bird as she sneaked off, running quietly through the grass for a considerable distance before she flew away. I then kept perfectly quiet until the man had passed well beyond the site of the nest after which the hen bird would run back and squat on her eggs. Approaching her very quietly, I sometimes found her so intent on keeping the other man in view that I was able to get within about 10 yards before she rose from her nest and fell flopping about on the ground as if with a broken wing, trying to draw me away from her eggs. These antics are not often indulged in by the bird when she has eggs in the nest, but if an intruder stands over the nest for any length of time, or if she has chicks hidden in the grass nearby, both cock and hen birds will return to the nest, flying round and round, uttering their sad little call, whilst the female will frequently alight on the ground and try to draw the intruder away by feigning illness or injury. The site selected for the nest is almost invariably wet upland, and even in Norway, Sweden and Finland, the nest is nearly always placed on a rise or high ground but, unlike so many other birds in these countries, they prefer entirely open country to that which is more or less covered with stunted tree growth.

The full clutch of eggs is four, and they are in shape the usual broad pyriform common to the family. They are extremely handsome, varying in ground colour from a pale fawn, cream or almost white, to a rich buff, whilst the markings consist of large bold blotches and spots of deep Vandyke brown, chocolate brown, black or deep blood colour. In a few eggs, there is a chestnut tinge both in ground colour and markings. The blotches are generally more numerous and largest on the larger half of the egg, where they sometimes form more or less of a cap. As this bird has only recently been separated from the British form, nearly all the measurements which have been given so far are those of both races, but Rey gives the average of 26 continental eggs as 51·4 × 34·1 mm.

Habits.—In India, the Golden Plover is only found either singly or in very small flocks, though it may associate occasionally with other waders, indeed the two birds which I obtained in Dibrugarh were shot out of very large flocks of the Eastern Golden Plover, three of these birds falling to my first shot and five to my second. Fortunately it was as the birds were just leaving for the North and the majority were in full breeding plumage though the difference in the colour of the axillaries always makes determination of the species very easy. In the Winter in countries where it is more numerous, the Golden Plover often associates in flocks of many hundreds, whilst during migration, both North and South, it collects in great numbers ; though almost immediately it arrives at its breeding grounds, the flocks break up and the birds are only to be seen in pairs. Nesting operations commence almost directly the birds arrive in the North and they do not assemble again in flocks until just prior to their leaving again for the South. This bird is essentially a game bird, for it is amongst the hardest of birds to approach, flies very strongly and, when shot, forms a quite first class dish for the table.

The ordinary call is a shrill but very pleasant *tuill-tuill* constantly repeated when on the wing. The warning cry, which is uttered by the bird upon some little eminence not far from the nest, is a sad, rather drawn-out *tu-ee*, *tu-ee* repeated at short intervals until he thinks the intruder has come too near the nest to be safe, when the note is sharpened and quickened and the hen bird at once sneaks away. The Golden Plovers' food consists of all kinds of insects, beetles, berries and shoots of many plants and, when feeding by the sea, of small mollusca, crustaceans and sea-worms.

PLUVIALIS DOMINICUS.

Charadrius dominicus Muller, Natur. System. Suppl., p. 116 (1776) Type-locality ; St. Domingo.

The typical form differs from the Eastern in having the upper parts more golden and also in having a longer and stouter bill.

PLUVIALIS DOMINICUS FULVUS.

The Eastern Golden Plover.

Charadrius fulvus Gmelin, Syst. Nat., i, (2) p. 687 (1789) Tahiti ; Blanf. and Oates, iv, p. 234.

Vernacular Names.—Chota-batian (Hind.) ; *Kotan* (Tam., (Ceylon) ; *Rana Watuva*, *Oliya*, *Maha Oliya* (Sing.)

Description : Breeding Plumage.—Forehead broadly white running back as a broad white supercilium and down the sides of the neck and breast ; lores black ; axillaries greyish-brown edged and tipped with white and centered darker. Otherwise similar to the preceding bird but with less gold spangling, especially on the wings.

Colour of soft parts as in the Golden Plover.

Measurements.—Wing 160 to 165 mm. ; tail 60 to 64 mm. ; tarsus about 40 to 44 mm. ; culmen 22 to 27 mm.

In Winter differs from the Golden Plover in being a little duller above and in always having grey axillaries.

Distribution.—Breeding in Siberia from the Kara Sea to West Alaska and south to the Amoor River. In Winter south to India, Burma, and Malay Peninsula and Archipelago, the Indo-Chinese countries and South China to Australia. In India it occurs as far south as Ceylon, where Wait records it as common throughout the Low Country. In Burma it is common from North to South.

Nidification.—The Eastern Golden Plover breeds practically throughout Siberia, in its western part sharing its breeding grounds with the European Golden Plover. In its nesting habits, it apparently differs but little from the previous bird, selecting similar sites for the nest and being just as difficult to approach. Seebohm records it as being about the most common bird at Golchika but he was never able to disturb the bird on its nest or to obtain eggs, though he obtained the chicks in down. The nest is the usual shallow depression well lined with whatever grass, weed or lichen may happen to be growing near, and well hidden. The bird appears to breed principally on the flats bordering rivers and on higher ground, further from them. The number of eggs laid is the usual four in a clutch, though McFarlane once obtained five. They differ from those of the European Golden Plover in being decidedly smaller and almost always more dull and paler. Judging also from the small number of eggs I have been able to examine, the markings are less bold and handsome.

Three clutches, each of four eggs, in my own collection were taken at the end of June or in the first week in July. Twenty-one eggs, including seven measured by Jourdain, average 47·6 × 33·4 mm., maxima *50·0* × 32·7 mm. and 48·3 × *35·6* mm., minima *45·0* × *31·8* mm. The breeding season seems to be from the first week in June to at least the second week in July and I have seen no eggs that are absolutely authentic, taken before the second week in June.

There is nothing to prove that the Eastern Golden Plover has ever bred within our limits or even within the limits of the Himalayas, but I have twice had eggs sent me from the Gyantse Plain which seemed to be undoubtedly those of a Golden Plover of some sort. Unfortunately in neither case were the birds shot and, so far as I could ascertain, the layers were either not seen at all, or were not seen sufficiently near to give any chance of identification. The eggs were taken at an elevation of about 13,000 feet and it is just possible that a few Eastern Golden Plover may remain on these lofty plains throughout the summer.

Habits.—In India this plover is comparatively common in the North-East, often occurring in very large numbers in Assam and Bengal, becoming more rare towards the West, though it is found as far as Sind and the North-Western Provinces. It extends south to Ceylon, whilst throughout Burma and further east it is common. The first few birds of this species used to arrive in Assam in early September and I have records of its being shot as early as the last week in August, these latter being nearly always birds of the year with no signs of breeding plumage on them, whereas the birds which arrived later occasionally had the remains of the black breast still visible. The birds soon lose this and begin to acquire it again in March and by the time they leave in April have often acquired the full breeding dress, in fact it was often noticeable that when feeding, the flocks often broke up into pairs, though these at once mixed with the main flock directly they were disturbed. In Assam and Burma, where it was probably more common than anywhere else during the Winter, it was often found in flocks of several hundreds and the larger the flocks the more difficult it was to approach. As a rule if we wanted to circumvent such a flock, our plan was for one of our party to detach himself from the rest who hid in any cover available, whilst he made a big circle round to the other side of the flock. In this way two or more guns often got a number of shots, whilst even the man deputed first to disturb them, provided he dropped to the ground quickly and hid himself, often obtained a right and left after the birds wheeled round on being first shot at. I do not know whether it is really so, but these birds always give me the impression of flying in very much more compact flocks than the European birds do and in consequence it was often possible to drop several birds in one shot without indiscriminate ' browning '. I have often myself obtained more than one bird in a single shot whilst Dr. Moore told me that once he had shot eleven, and on another occasion I saw Mr. C. Holder drop seven birds out of a flock which by chance crossed him when he was shooting Green Pigeon. The food of this Plover is the same as that of *P. a. apricarius* but those I examined had fed very largely on small grass-hoppers and tiny coleoptera. Its note is said to be more like that of the Grey Plover than the Golden Plover. Seebohm and others describe its note as a plaintive *Ko*, sometimes prolonged into a mournful *Ko-ee*. The only note which I know is that uttered during the winter when the bird is in flocks and this is a very charming double whistle, sounding like a soft though high pitched *Tu-ee, tu-ee*, uttered constantly by the bird both as the flocks take to wing and again before they pitch, or less often, as they start on their flight.

GENUS : VANELLUS.

Vanellus Brisson, Orn. i, p. 48 (1760).

Type by taut., *Tringa vanellus* Linn.

This genus is distinguished from all other genera in the *Vanellinæ* by the presence of a large recurved crest and by the absence of either lappet or wing-spur.

The bill is short and slender, with a flattened culmen and slightly swollen dertrum ; the linear nostril is placed in a groove which extends over more than half the upper mandible ; the wings are very rounded. In the male, the third primary is longest and the second equals the fourth ; in the female, the second and third are longest and the first equals the fourth ; the tarsus is moderate and reticulated all round ; there is a small hind toe.

The genus contains but one species, which extends over the greater part of the Temperate Old World.

VANELLUS VANELLUS.

The Lapwing, Peewit, or Green Plover.

Tringa vanellus Linn., Syst. Nat., 10th ed., i, p. 148 (1758) (Sweden).

Vanellus vulgaris.—Blanford and Oates, iv, p. 130.

Vernacular Names.—None recorded.

Description : Breeding Plumage.—Face, forehead, crown and long crest of narrow feathers black, glossed with green; feathers round the eye, lower ear-coverts, sides of the head and neck white; a black patch from the black face to the upper ear-coverts; back, rump, scapulars and innermost secondaries bronze-green, highly glossed; the scapulars marked with violet-purple; upper tail-coverts cinnamon; tail white with a very broad black subapical band glossed green; wing-coverts glossed deep blue, purplish in some lights; primaries and outer secondaries black with pale brown tips to the first four primaries; throat, fore-neck and breast black, the black running up to the back on the anterior neck; under tail-coverts cinnamon; under wing-coverts black; remaining lower plumage and axillaries white.

Colours of soft parts.—Iris brown; bill black; legs and feet orange-brown.

Measurements.—Wing 220 to 236 mm.; tail 108 to 119 mm.; tarsus 44 to 48 mm.; culmen 23·0 to 26·5 mm. (Hartert).

In non-breeding plumage the crown is brown rather than black; the face, chin, throat and fore-neck are white, more or less speckled or marked with brown or black; the scapulars, inner wing-coverts and innermost secondaries are edged with fulvous as are the black feathers of the breast.

Young birds have the upper parts brown, each feather edged with fulvous; the back is slightly glossed with purple-bronze and the wings with green; lower plumage like the adult in Winter.

Nestling in down.—Hind-neck dull white, remaining upper parts fulvous-brown, mottled with black; a black line from eye to eye round the back of the crown; a broad, but broken median black line down the back and a fairly well-defined black line from wing to wing bordering the back and round the tail; a black line from the side down the thighs; upper fore-neck blackish; remaining underparts white or dull fulvous-white.

Distribution.—The whole of Europe and North Asia. In Winter South to North Africa, India, Burma, the Indo-Chinese countries and South China. In India it is comparatively common in the Punjab and North-West. It is a regular, though not common, visitor to Assam and Eastern Bengal and has also been shot in Burma.

Nidification.—The Lapwing is one of the earliest of breeding birds and in the southern parts of its breeding areas eggs may be taken at the end of March and sometimes as early as the last week in February. The majority of eggs will, however, be found in early April or, in the further North, in May. Like all Plovers, the Lapwing deposits its four eggs in a natural hollow in the ground, sometimes, however, scraping out one for itself. The hollow may be absolutely unlined, or it may be so well lined with grass, bracken, or other material that it can almost be said to form a good nest. When breeding, as it so often does, in fallow fields on rising ground, the bird usually selects the crest of a rise and to those who know its habits well, it is often easy to go straight to the portion of the field where its eggs are most likely to be found. On the other hand it often breeds in the flat sea-side marshes and low-lying river lands. The eggs vary most extraodinarily in colour, the ground colour may be anything from a pale yellowish stone, pale olive brown or greyish brown to a warm buff or stone colour, whilst the markings differ in various eggs from tiny specks to bold blotches. They are generally distributed fairly numerously over the whole surface of the egg but in some cases, especially where the markings are bold, they are less profuse, leaving the ground colour visible in big patches. Occasionally erythristic eggs are obtained and more often eggs almost entirely of a pale blue-grey, showing a complete absence of superior or more superficial colouring. In shape the eggs are broad peg-top, whilst a hundred eggs average 47·0 × 33·7 mm., maxima *58·0* × 32·5 mm. and 47·4 × *37·2* mm., minima *42·3* × 33·5 and 44·7 × *31·2* mm.

It would be difficult to find any bird more shy or difficult to approach when nesting and it is practically impossible to approach within sight of a sitting bird. The male bird is invariably on the *qui vive* against all intruders giving warning to his mate long before their approach becomes dangerous. When the young are hatched, however, their great anxiety often conveys a clue to where these are lying hid.

Habits.—In India, the Lapwing is fairly common during the cold weather from October to March, in the North-West extending as far as the United Provinces. East of this it extends in fast decreasing numbers as far as Cachar and Lakhimpur, south and east of the Brahmapootra, in both of which districts I have personally shot specimens. In Europe it often collects in flocks of immense size before migrating; but in India, even in the North-West, only small flocks are seen and very often only pairs or single birds, whilst when one gets to Assam, the latter only are met with. It extends south on the West to the Bombay Presidency but in the East, not, I think, further south than Bengal whilst even there it is extremely rare. It is capable of great speed in flight when necessary but for the most part it saunters along at a very leisurely pace, whilst in the breeding season, it indulges in most extraordinary evolutions in the air, emulating the most modern stunts of our aviators. Its well-known call has been syllabified into the name of *Pee-wit* but its cry is really more of a mew than this word expresses. It is a plaintive, wild note and once heard, is alone almost sufficient to identify the bird for a certainty. It feeds on all kinds of insects, worms and beetles and is a great destroyer of wire-worms on ploughed land, where, because of this, it is of the greatest value to farmers. On the other hand many of its former haunts have now been rendered uninhabitable by the use of slag manure which destroys its food and drives the bird away to other quarters. Its eggs are famous all over Europe as an article of food but in England their sale has now been made illegal, a well-meant measure which may, however, act more against than in the interests of the bird, as with such early breeders, many of the first eggs laid are destroyed by frost and cold and again, many of the young first hatched are starved because of the insufficiency of food generally available. A more effective measure would probably have been to restrict the taking of their eggs up to some date such as the first or tenth of April.

GENUS : CHETTUSIA.

Chettusia Bonaparte, Icon. Faun. Ital. Livre 23, (1838) Type by mon:, *Charadrius gregarius* Pallas.

When writing the *Fauna* of India, I retained, with some doubt, the two species included in this genus by Blanford. The two differ both in colour and in structure rather definitely and *Chettusia leucura* should perhaps be separated under the generic name *Eurypterus* of Sharpe.

This genus differs from *Vanellus* in having no crest and in having much white on the wing ; in *C. gregaria* the tarsus is reticulated but in *C. leucura* the reticulations become small scutellations.

Key to Species.

A.	Some black on the tail ; a broad white supercilium	*C. gregaria*
B.	Tail all white ; no supercilium ...	*C. leucura*

CHETTUSIA GREGARIA.

The Sociable Lapwing.

Charadrius gregarius Pallas, Reise Reichs. Russ. i, p. 456 (1771) (Volga).

Chettusia gregaria.—Blanf. and Oates, iv, p. 231.

Vernacular Names.—None recorded.

Description : Breeding Plumage.—Forehead and broad supercilium white ; crown, lores and a line behind the eye black ; hind neck narrowly white, meeting the supercilia ; chin white ; upper plumage, throat and breast light ashy-grey ; upper tail-coverts white ; tail white, the central feathers suffused with grey ; wing-coverts ashy-grey, the greater secondary-coverts broadly edged white ; primary-coverts and primaries black ; the latter with concealed black bases and the innermost one or two with white tips and edges to the inner webs ; outer secondaries pure white, inner like the back ; lower breast black, the longest anterior feathers chestnut ; vent, posterior flanks, abdomen and under tail-coverts white ; tail white with a broad black band on all but the two outermost pairs of feathers and with only a black patch on the inner webs of the third outer pair.

Colours of soft parts.—Iris brown ; bill, legs and feet black.

Measurements.—Wing 196 to 204 mm.; tail 84 to 91 mm.; tarsus 59 to 62 mm. ; culmen 29 to 31 mm.

In non-breeding plumage, the crown is brown, the feathers sometimes showing black centres ; the forehead and crown more or less buffy-white ; chin and throat white ; breast smoky-grey, mottled with brown ; abdomen, vent and posterior flanks smoky-white.

Young birds like the adult in non-breeding plumage, the feathers of the upper parts edged with light rufous.

Distribution.—South-Eastern Russia and Asia as far as Central Siberia, migrating south to North Africa and India and west to Western Europe.

It occurs as far south as Ceylon and has been obtained on several occasions in that island.

Nidification.—The breeding of the Sociable Lapwing very closely resembles that of the Common Lapwing. Its breeding area extends from South Central and Central Russia, through Asia Minor to Eastern Turkestan and South-West Siberia, and—rarely—to South Central Siberia as far Tomsk. The bird almost invariably selects wide open spaces of uncultivated or semi-cultivated country but occasionally also breeds in cultivated fields before the crops have attained any height. In the Crimea it is said sometimes to breed in potato fields. The nest is merely a scraping in the ground like that of our Lapwing, often quite unlined except for a small amount of fallen rubbish, but at other times is a comparatively well-made nest of grass and weeds. This is more especially the case when the site chosen is one in wet bog-land or on the muddy shores of lakes and rivers. There are a few birds who breed in Southern Russia as early as the middle of April and I have a clutch taken in Turkestan on the 26th of March. A favourite time, however, seems to be from the middle of May to the middle of June. A few birds lay, possibly second clutches, as late as July. The eggs may, in almost every instance, be duplicated by those of our English Lapwing but, taking them as a whole, the pale grey or cyanic type of egg is much more common and, at the other extreme, very dark eggs with a greenish ground colour are not rare. I have seen no erythristic eggs of this bird but I believe there are such in existence, as for instance, in the Museum in Leningrad. In shape the eggs are the normal blunt pyriform of the family. Eighty-five eggs average 46·2 × 33·5 mm.; maxima *49·4* × 31·9 mm. and 47·1 × *34·1* mm.; minima *43·1* by 32·3 mm.; 44·9 by *31·3* mm.

The bird is said to be shy and to leave its nest long before any intruder approaches within sight, sneaking quietly away for some distance before it rises. When, however, the young are hatched, the old birds always give away their vicinity by circling round over them uttering their loud complaining call. At the same time it is far less shy than our English bird, so much so that some observers have said that with reasonable precaution it is possible to approach within quite a short distance of the sitting hen.

Incubation is said to take about 24 days.

Habits.—In flight, food and manners generally, the Sociable Lapwing is very much like our Lapwing but in India, at all events during the non-breeding season, it is very much less shy. In India it is not uncommon in the North-West, ranging south as far as the Southern Bombay Presidency and east to the United Provinces, Behar and Western Bengal. Within our limits it is found either in small parties or in pairs, or single individuals mixed with other Plover. Before migrating from its breeding habitat it is said to assemble in vast multitudes, whilst even in Mesopotamia and parts of Persia it occurs in very great numbers.

One of my correspondents speaks of seeing 'many hundreds' in Persia.

The call is a single harsh wailing note, frequently uttered both on the wing and when the bird is on the ground, whilst its alarm note is a quick loud single call. Its flight, although like that of the Lapwing, is quicker, more direct and consists of a rather more rapid beating of the wings, at the same time it often indulges in aerial revolutions, very similar to the Lapwing's courting flight.

CHETTUSIA LEUCURA.

The White-tailed Plover.

Charadrius leucurus Licht., in Eversm., Reise, av. Orenb. nach Buchara, p. 137 (1823) (Kuwan).

Chettusia leucura.—Blanf. and Oates, iv, p. 233.

Vernacular Names.—None recorded.

Description.—Upper plumage light brown, suffused with a purple pink, except on the head and hind-neck; forehead and indistinct supercilia pale greyish-white; upper tail-coverts and tail pure white; median and greater wing-coverts with broad black bars and white tips forming four wing-bars; primaries black; outer secondaries white, with broad black bars gradually decreasing in width until the central feathers are all white and thence grading into the innermost, which are like the back; chin, throat and fore-neck ashy-grey; breast purer grey; abdomen, vent and under tail-coverts rosy-white or rosy-buff; axillaries white.

Colours of soft parts.—Iris brown or blood-red; bill black; legs pale yellow.

Measurements.—Wing 169 to 179 mm.; tail 73 to 78 mm.; tarsus about 72 to 77 mm.; culmen 28 to 31 mm.

Young birds have the upper parts very dark brown, the feathers with broad fulvous edges; the underparts like the adult but pale and looking very washed out.

Distribution.—Breeding throughout Mesopotamia, Persia, Turkestan and Transcaspia. In winter South India and North Africa.

Nidification.—Pitman found this Plover breeding in large colonies in Mesopotamia from the middle of May to the end of June, whilst Cox and Cheeseman took eggs, probably second layings, in July. The birds nest on the shores and higher pieces of ground in and around swamps or by lakes. At Meseyib, Pitman found a colony of several hundred pairs breeding on a part of the great swamp, laying their eggs wherever there were a few feet of mud or dry land above the surrounding water. So numerous were the birds that on some patches of island only a few feet across, four or five pairs of birds were breeding together. The nests were just the usual scratchings in the earth, lined with grass and weeds, in a few cases with shells or, occasionally, quite unlined. There appeared to be no attempt at concealment, for though in some cases the eggs were partially hidden by tufts of grass, in others they lay in the open nest quite exposed. The eggs numbered three or four, the latter as often as the former and, in appearance, are very much like small dull-coloured Pee-wits' eggs, rather more oval and narrow and less peg-top-shaped than most Plovers' eggs. In the majority of the eggs the ground-colour is a pale dull clay, in a few eggs tinged with olive. The markings consist of fairly bold blotches, spots and smudgy dots of blackish or reddish-brown distributed freely over the whole surface. The secondary markings consist of pale grey or lavender blotches, always few in number and sometimes absent altogether.

Eighty eggs average 39·5 × 28·3 mm. ; maxima *43·2* × 29·0 mm. and 41·3×*29·2* mm., minima *37·5*×28·1 mm. ; and 38·8×*27·0* mm.

Pitman says that, though shy, he often saw birds sitting on their nests until he was quite close to them and that when disturbed the birds were quickly back again as soon as he left the place. Logan Home says that the birds in the colonies he found at Abu Aran on June 8, were very shy and that, unlike the Pratincoles and Little Terns which were also nesting there, the Plovers were very wary and would not go on to their nests so long as he stayed on the island. Bird observers describe them as very noisy at their breeding grounds, constantly wheeling round uttering loud cries. In parts of the Euphrates Valley these birds breed in company with Stilts but make less of a nest and generally select drier ground on which to make it.

Habits.—The White-tailed Plover is found much more commonly in India than the preceding bird, occurring mostly in the Punjab and North-west India, and extending South to Mysore and East to Calcutta and Dacca, from both of which places I have seen specimens. Unlike more of our Plovers, this bird is essentially a swamp lover and is seldom to be found at any distance from marshes and lakes, though occasionally it may be found feeding on cultivated land, especially wet ploughed land. It assembles in flocks of considerable size in Sind and the Punjab, but to the East and the South it occurs only in small parties or as single stragglers. When in flocks, it is very shy and difficult to approach but single birds seem to be much less wild and, when in company with other waders and plovers, can often be approached within shot. It feeds very largely on water insects, worms, grubs and tiny freshwater shrimps and mollusca. Its flight is very similar to that of the Sociable Plover, as is its voice, and it is said to be quite as noisy as that bird especially in the breeding season.

(*To be continued*).

REVISION OF THE FLORA OF THE BOMBAY PRESIDENCY.

BY

E. BLATTER, S.J, Ph.D., F.L.S.

PART XV

(*Continued from p. 900, Vol. XXXIV.*)

(*With 7 plates*).

ARACEÆ (Cke. ii, 816).

BY

E. BLATTER S.J., Ph.D., F.L.S. & C. McCANN, F.L.S.

Genera 107. Species 1000.—Tropical and temperate.

Cooke mentions 11 indigenous genera. We add *Rhaphidophora* as new to the Presidency and treat *Colocasia* as an indigenous genus. We are not considering the cultivated species.

Key, partly after Cooke :

A. Flowers 1-sexual, monœcious (often diœcious in *Arisæma*).
  I. Water or marsh plants. Spadix without a barren appendix.
    1. Floating stemless herbs ; leaves forming a rosette-like tuft ... ... 1. *Pistia.*
    2. Submerged aquatic or marsh herbs
      (*a*) Ovaries in one whorl ... ... 2. *Cryptocoryne.*
      (*b*) Ovaries spirally arranged ... ... 3. *Lagenandra.*
  II. Terrestrial tuberous herbs.
    1. Spadix with a barren terminal appendix
      (*a*) Ovules not parietal
        i. Male flowers stipitate ; flowers often diœcious ... ... 4. *Arisæma.*
        ii. Male flowers sessile or nearly so ; flowers always monoecious
          (1) Flowers and leaves present together
            (i) Ovules 1–2, basal ... ... 5. *Typhonium.*
            (ii) Ovules many, basal and apical. 6. *Theriophonum.*
          (2) Flowers appearing before the leaves
            (i) Ovules orthotropous ; males and females remote ; neuters present ... ... 7. *Sauromatum.*
            (ii) Ovules anatropous ; males and females contiguous ; neuters 0. 8. *Amorphophallus.*
      (*b*) Ovules many, parietal ... ... 9. *Colocasia.*
    2. Spadix without a barren appendix ; ovules parietal
      (*a*) Female inflorescence adnate to base of spathe, stigma stellate. 10. *Ariopsis.*
      (*b*) Spadix free from the spathe ; stigma discoid ... ... 11. *Remusatia.*

B. Flowers hermaphrodite, a few rarely unisexual. Perianth **0**.
Spadix without an appendix, sessile; ovary 1—2-celled; berries confluent ... 12. *Rhaphidophora.*

C. Flowers hermaphrodite. Perianth of 4-6 segments. Spadix without an appendix, flowering upwards. ovary 1-3-celled; stem scandent, leaves distichous ... ... 13. *Pothos.*

1. Pistia, Linn.

Species 1.—Tropics and subtropics, with the exception of Polynesia and Macronesia, sometimes ascending up to 5,000 or 5,800 ft., mostly in the plains, sometimes also in somewhat brackish water.
The Bombay plants all belong to the following variety:

Pistia stratiotes, Linn. Sp. Pl. (1753) 963, **var. cuneata** Engl. in Fl. Bras. III, 2 (1879) 214.—*P. stratiotes* Linn.; Roxb. Corom. Pl. III (1819) 63, t. 269; Fl. Ind. III (1832) 131.—*P. crispata* Bl. in Rumphia I (1835) 78.—*Koddapail* Rheede Hort. Malab. XI (1692) 63, t. 32.—*Kiambam kitsii* Rumph. Herb. Amb. VI, 177.

Leaves almost obtriangular, tip rotundate, slightly emarginate, the upper margin slightly crisped or not crisped.

2. Crypptocoryne, Fisch.

Species 40.—Indo-Malayan. Marsh plants.
Cooke mentions 3 species: *C. retrospiralis*, *C. spiralis*, *C. cognata* We add 4 more not known from the Presidency before and describe 2 new ones.

A. Upper tube of spathe almost absent or much shorter than the lower tube
  I. Leaf-blade broadly lanceolate. Blade of spathe spirally twisted from the base ... 1. *C. Huegelii.*
  II. Leaf-blade linear-lanceolate or linear-oblanceolate. Blade of spathe more or less spirally twisted from the base
    1. Blade of spathe with the margin entire ... 2. *C. unilocularis.*
    2. Blade of spathe with the margin denticulate
      (*a*) Leaves up to 20 cm. long ... ... 3. *C. spiralis.*
      (*b*) Leaves up to 85 cm. long ... ... 4. *C. tortuosa.*

B. Lower tube of spathe slightly wider, below the upper tube more or less constricted
  I. Leaf-blade lanceolate to linear-lanceolate, acute at the base, gradually narrowed into the petiole
    1. Blade of the spathe long, linear-lanceolate, spirally twisted along the whole length ... ... 5. *C. retrospiralis*
    2. Blade of spathe ovate-lanceolate, contracted into a long subulate tail. Tube of spathe shorter than the long caudate lamina .. .. 6. *C. cognata.*
  II. Leaf-blade broadly lanceolate-acuminate ... 7. *C. cognatoides.*

C. Lower tube of spathe narrower than the upper tube and several times shorter; blade broadly ovate-lanceolate, fimbriate-ciliate ... ... 8. *C. ciliata.*
Imperfectly known species: Leaf-blade elliptic-lanceolate, acute at both ends ... 9. *C. Dalzellii.*

1. **Cryptocoryne Huegelii,** Schott Aroid. (1853) 8, t. 12; Prodr. (1860) 18; Hook f. F.B.I. vi, (1893) 494; Engler in Engl. Pflanzenr. iv, 23F (1920) 236.

Description : Petioles 15–20 cm. long, vaginate beyond the middle. Leaf-blade oblong-elliptic, narrowed into the petiole, acute at the apex, 15–18 cm. long, in the middle 3-4 cm. broad, primary lateral nerves several on either side, diverging at an acute angle from the midnerve. Peduncle 2–3 cm. long. Tube of spathe 20 cm. long, lower tube narrowly cylindric, 2·5 cm. long, 0·6–1 cm. wide, upper tube scarcely any, passing over into the blade. Blade linear-lanceolate, long acuminate, about 17 cm. long, 1·5 cm. broad below, inside with transverse, parallel, erose lamellæ, spirally twisted along its whole length. Female inflorescence 4–5-gynous, male 4 mm. long, thinly cylindrical, the interval between the two inflorescences about 1·2 cm. long; appendix short, stout. Ovary oblong, narrowed into a thin style; stigma oblong-oval.

Locality : Savantvadi (Dalgado in Herb. Calc.).

Distribution : The only other specimen is Huegel's No. 2446 in the Hofmuseum Herb. Vienna, collected in the East Indies, but no definite locality is given.

2. **Cryptocoryne unilocularis,** (Roxb.) Kunth Enum. iii, (1841) 13; Wight Ic. iii, (1843) t. 774 (*non* Schott).—*Ambrosinia unilocularis* Roxb. Fl. Ind. iii, (1832) 493.—*Cryptocoryne Roxburghii* Schott Prodr. (1860) 18; Dalz. & Gibs. Bombay Fl. (1861) 257; Hook. f. F.B.I. vi, (1893) 494.—*Arum spirale* Grah. Cat. Bomb. Pl. (1839) 228.

Description : Caudicle about 5 mm. thick; internodes short. Petiole scarcely distinct, broadly vaginate, vagina passing into the blade, blade narrowly linear-acuminate, 20–30 cm. long, 0·5-1 cm. broad, lateral nerves subparallel with the midrib. Peduncle very short; lower tube of spathe oblong almost cylindrical, about 1·5 cm. long, 3·5-4 mm. wide, inside purple-spotted, upper tube narrower, 2 mm. wide and scarcely 1 cm. long; blade purple, narrowly linear-lanceolate, spirally twisted. Femlae inflorescence 4-gynous, male about 3 mm. long, separated from the female by a naked interval of about 1 cm.; appendix shortly conical. Ovary elongate-oblong; ovules biseriate. Style short, stigma oval. Capsule unilocular.

Locality : Konkan (Herb. Kew ex Engler).

Distribution : N. Circars, Konkan.

We have not seen any specimens. Roxburgh was the first to mention the plant from India, giving as locality 'Coromandel.' Graham mentions it in his Cat. Bombay Pl., but there is no specimen to confirm his identification. In Dalzell and Gibson's Bombay Fl. the species is mentioned as being common. This statement induces Cooke (Fl. Bomb. II, 819) to doubt its occurrence in the Presidency. It is certainly strange that a plant which is said to be common, should not have been seen during a period of 70 years.

Cooke says that Dalzell has supplied no specimen of this species and Haines has not found any at Kew. Engler mentions the same localities as Hook. f. in the F.B.I., viz., 'the Northern Circars and the Konkan', adding a mistake by including the N. Circars in the W. Ghats of the Malabar Coast. In addition, he gives as source for his information regarding the two localities the 'Herb. Kew.' If he relied on the F.B.I. the next question would arise whether Hook. f. has seen any specimens, and if he has not, why he included Graham's *Arum spirale* and Dalzell and Gibson's *Cryptocoryne Roxburghii* under Schott's *C. Roxburghii*? Their descriptions are certainly not such as to lead unmistakably up to *C. Roxburghii* Schott.

3. **Cryptocoryne spiralis** Fisch. ex Wydler in Linnæa v, (1830) 438; Bl. in Rumphia i, (1835) 84, t. 36 C.; Wight Ic. iii, t. 773; Schott Melet. (1832) 6; Aroid. (1853) 8, t. 13; Schnitzl. Iconog. fasc. iv, (1846) t. 72; Hook. f. F. B. I. vi, (1893) 494; Cke. ii, 818; Engler Pflanzenr. iv, 23 F (1920) 237.—*Arum spirale* Retz. i, (1779) 30; Bot. Mag. t. 2220; Lodd. Bot. Cab. t. 525.—*Ambrosinia spiralis* Roxb. Hort. Beng. (1814) 65; Fl. Ind. iii, (1832) 492.

Description : Caudicle 10–20 cm. long or longer, about 4–5 mm. thick, stoloniferous; internodes 1-1·2 cm. long. Petiole scarcely distinct, broadly vaginate, vagina passing over into the blade; blade linear-lanceolate, 10-15 cm. long, 8–12 mm. broad, long-narrowed from the middle to the base; lateral nerves ascending towards the apex. Peduncle very short, included together with the tube in a sheath. Lower tube of the spathe, including the inflorescence, obconical, about 2 cm. long, almost 1 cm. wide above, 7–8 mm.

below ; upper tube scarcely any ; blade purple, linear-lanceolate, 10 cm. long or longer, below more than 1 cm. broad, within strongly transversely lamellate, with a denticulate margin, purple, at first twisted, finally straight. Female inflorescence 5-gynous, male one 3-4 mm. long, separated from each other by a naked interval of about 8 mm. ; appendix shortly conical, 1·5 mm. long. Ovaries oblong, narrowed into a short, outward-bent style ; stigma broadly elliptic.

Locality : Khandesh : Bhusawal (Gammie !).—*Konkan* (Dalzell, Stocks).—*Deccan :* Poona (Herb. Econ. Bot. !).—*N. Kanara :* Santgul (Talb. 860 ! Herb. Calc.) ; Siddhapur in rice fields, 1,500 ft., rainfall 100 in. (Sedgwick 7066 !, 7066b !).—It grows on the margins of ditches and ponds and in rice fields, submerged during the rains.

Distribution : From Khandesh to N. Kanara, Calicut, Coromandel Coast, Pondicherry, Bengal, E. Bengal, Ceylon.

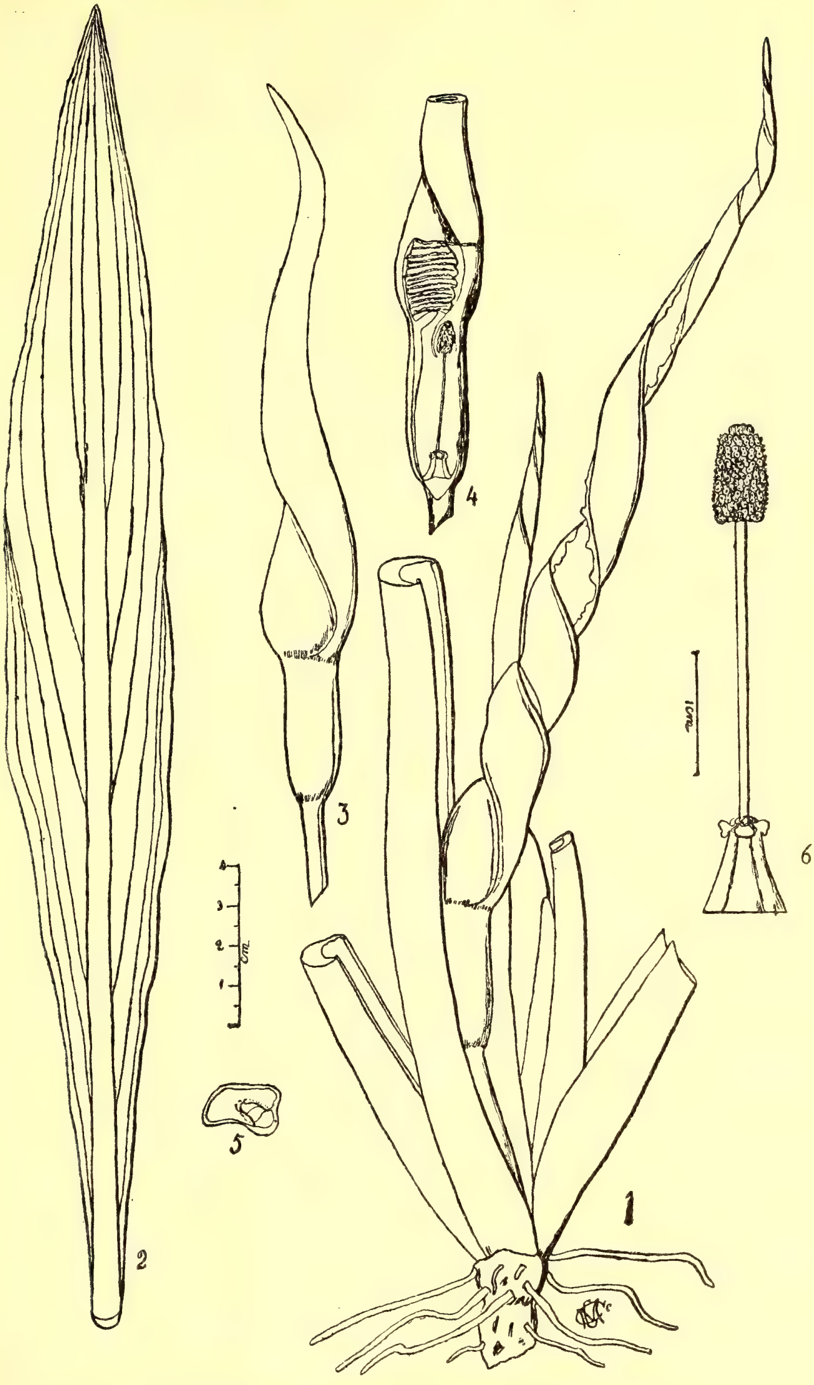
Flowers : Nov. (Poona) ; Dec. (Bhusawal).

4. **Cyrptocoryne tortuosa**, Blatter & McCann *sp. nov.* [*Pertinet ad sectionem Unitubulosarum* Engl. *Accedit ad C. Huegelii* Schott *sed differt lamina foliorum lineari-lanceolata vel lineari-oblanceolata, foliis duplo longioribus pedunculo longiore, spatha multo longiore, spathæ lamina coriacea margine denticulata inferne 8·5 cm. lata intus rugosissima, inflorescentia mascula longiore, interstitio inter inflorescentiam femineam et masculam maiore, stigmate discoideo margine sinuato, appendice minime truncata.*]

A tall tufted herb. Rhizome 1·5 cm. thick, descending perpendicularly and getting thinner, with very long vermiform roots. Leaves including petioles up to 85 cm. long, upright, upper part of lamina slightly recurved. Petioles vaginate at base for about 20 cm., then deeply channelled with sharp edges for about 25 cm., fleshy, spongy, striate, 8 mm. diam. from dorsal to ventral side, 1·5 cm. from side to side, purple or pale green tinged with purple. Lamina slightly inequilateral, up to 40 cm. long and 6·5 cm. broad where broadest, dark green above, paler beneath, linear-lanceolate or linear-oblanceolate, apex acute or acuminate or subobtuse, sometimes apiculate, margin entire, very narrowly hyaline, undulate ; midrib very stout, semicylindrical, 5–7 mm. diam., striate, slightly depressed above, very prominent below, light green and striate with purple below ; lateral nerves 3 at base on either side running up for ¾ the length of the blade and disappearing into the margin, besides 3–7 on either side starting at different heights and running into the tip, all depressed above, prominent beneath, and communicating by transverse veins. Peduncle up to 8 cm. long, 8 mm. diam., cylindrical, slightly compressed, slightly thicker upwards, enclosed by a cataphyll and the vagina of a leaf. Cataphyll linear, membranous, 12 cm. long, 1 cm. broad, margins slightly incurved, tip rounded. Tube of spathe underground. Spathe up to 27 cm. long. Tube white or tinged with red purple, trigonous-cylindrical, flattened on the ventral side, convex on the dorsal 4 cm. long, 1·5 cm. broad transversely. Lamina thickly fleshy-coriaceous, stiff, brittle, lanceolate, long acuminate-caudate, 23 cm. long, up to 8·5 cm. broad at base, dark purple on both sides, spirally twisted from the base either to the left or the right (in bud the spathe is not twisted, then the lower part becomes twisted and in flower the whole blade, and finally it uncoils without spreading out entirely), lower part of blade very strongly rugose inside, diminishing upwards, the ridges in the lower part 2–3 mm. high, transverse, more or less parallel, purple, except sometimes for the lowest cm. yellowish ; margins of blade before opening out kept together by a row of teeth on each margin which are about 2-4 mm. long. Spadix 3·3 cm. long. Female inflorescence 6 mm. long, at base 7 mm. diam.; ovaries 6, verticillate, connate ; stigmas irregularly discoid, cream-coloured, very minutely papillose, with the margins undulate and tinged with purple. Nude part of spadix between male and female inflorescences 2 cm. long, filamentous cream-coloured. Male inflorescence 7 mm. long, 3·5 mm. diam., cylindrical, yellow. Flowers diandrous. Stamens very short. Tip of spadix adnate to the septum of the spathe. Appendix white, truncate, about 1·5 mm. broad, scarcely 1 mm. long.

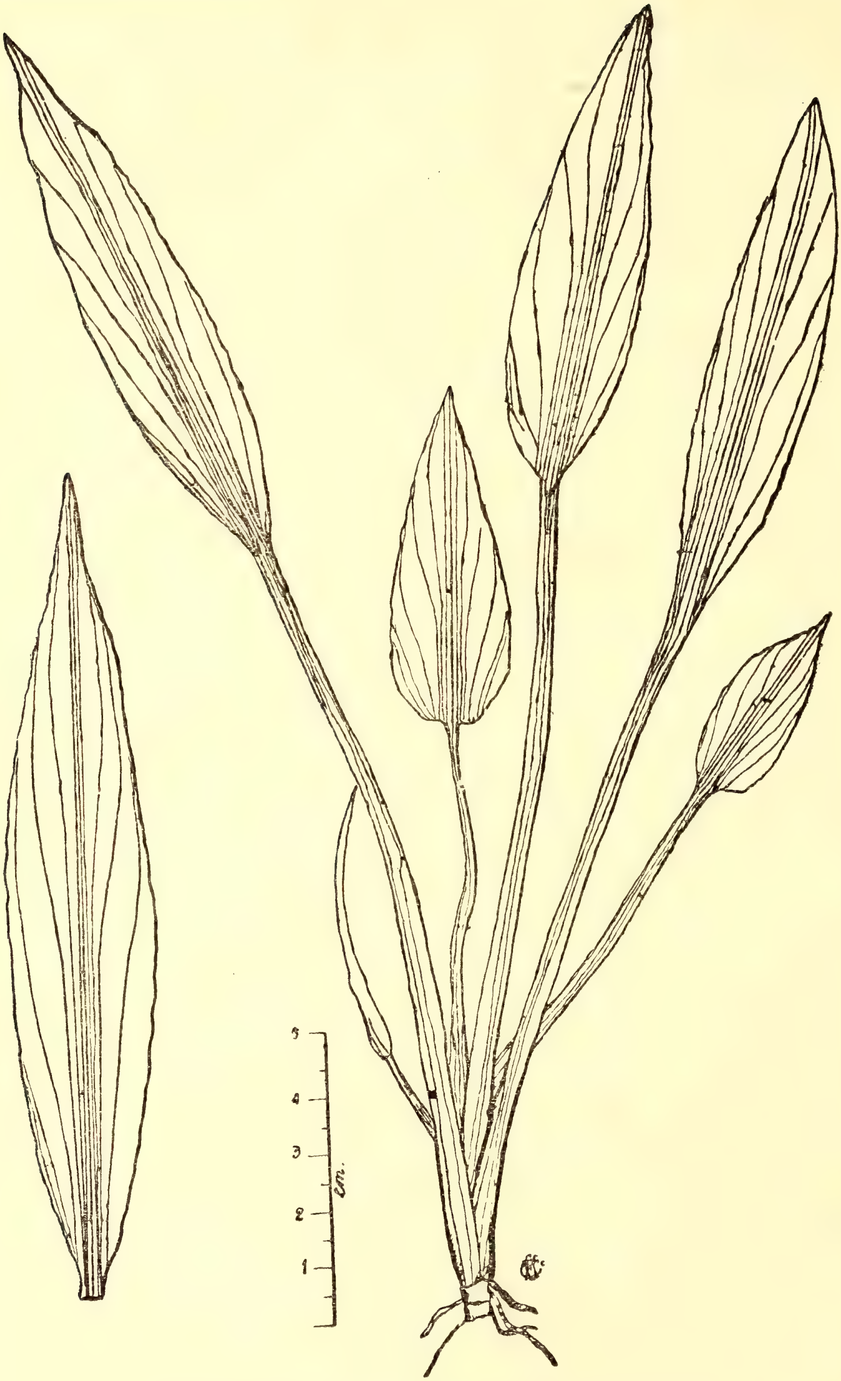
Locality : W. Ghats : Edge of a ditch at Lingmala near Mahableshwar, alt. 4,000 ft. (McCann 3331 ! type, 3335 !, 3336 !, 3340 !, co-types).

Flowers : 24th September 1930.



Cryptocoryne tortuosa Blatter & McCann, sp. nov.

1. Plant with open flower.
2. Leaf.
3. Bud.
4. Section of flower.
5. T. S. showing septum with valve in tube.
6. Spadix.



Cryptocoryne cognatoides, Blatter & McCann, sp. nov.

5. **Cryptocoryne retrospiralis** (Roxb.) Fisch. ex Wydler in Linnæa v, (1830) 428; Kunth Enum. iii, (1841) 12; Wight Ic. iii, t. 772; Cke. ii, 818.—*Ambrosinia retrospiralis* Roxb. Fl. Ind. iii, (1832) 492.

Description : Cke. i, 818.

Locality : Konkan : Bombay (Law); banks of the Pen River (Law); beds of rivers (Gibson); river-bed near Mira (Gibson 151).—*Deccan :* Poona, on river-banks (Perrotet, Ranade! Herb. Econ. Bot.!); Ganeshkhind Bot. Gard. (Patwardhan!).—*N. Kanara :* Nugi (Talbot 1583!, Herb. Calc.); Arbail (Talbot!).

Distribution : Konkan, Deccan, N. Kanara, Mysore, Travancore, Carnatic, Godavari District, Chota Nagpur, E. Bengal, Assam, Burma.

Flowers : Jan. (N. Kanara).

6. **Cryptocoryne cognata** Schott in Bonplandia, v, (1857) 222; Hook. f. F. B. I. vi, (1879) 494; Cke. ii, 819; Engler Pflanzenr. iv, 23F (1920) 247.

Description : Cke. ii, 819.

Locality : Konkan (Stocks). So far endemic.

7. **Cryptocoryne cognatoides** Blatter & McCann *sp. nov.*

[*Pertinet ad sectionem Bitubulosarum* Engler. *Accedit ad C. cognatam* Schott *a qua tamen differt radice non tuberosa, foliorum laminis late lanceolato-acuminatis, basi acutis, vel cuneatis, vel rotundis vel subcordatis, nervatione, pedunculis multo longioribus.*]

Herba rhizomate prædita 0·7 cm. crasso (non bulboso). Foliorum petioli 20 cm. attingentes vaginati ; lamina late lanceolato-acuminata 20 cm. attingens, medio 2-3 cm. lata basi acuta, vel cuneata, vel rotundata vel subcordata, margine undulata, nervi 3 centrales a basi foliorum usque apicem currentes, laterales utrinque 3 adscendentes deinde in apicem exeuntes. Pedunculus 5-5·5 cm. longus. Spathæ tubus 5 cm. longus, inferne 7 mm., superne 5 mm. amplus, lamina late elongato-lanceolata, 5·2 cm. longa, minime tortuosa, intus transversaliter rugosula. Spadicis inflorescentia feminea 5·5 mm. longa, mascula vero ca. 4 mm. longa, ambæ interstitio 2·2 cm. separatæ ; appendix conicus, brevissimus.

Locality : N. Kanara: In running water (T. R. D. Bell 3091! type, 3091a! 3091b! co-types).

Flowered in October 1917.

8. **Cryptocoryne ciliata** (Roxb.) Fisch. ex Wydler in Linnæa v, (1830) 428; Schott Melet. i, (1832) 26; Bl. in Rumphia i, (1835) 85; Wight Ic. iii, (1840-56) t. 775; Hook. f. F. B. I. vi, (1893) 492.—*Ambrosinia ciliata* Roxb. Corom. Pl. vii, (1819) 90, t. 294; Fl. Ind. iii, (1832) 491.—*Cryptocoryne elata* Griff. Not. iii, (1851) 434; Ic. Pl. As. (1851) t. 170, 171 (*alata*).

Description : Caudicle 1-2 cm. thick, stoloniferous; internodes very short, roots numerous, sometimes a longer internode between a series of shorter ones. Petioles 10-30 cm. and longer, 4-6 mm. thick, glabrous or papillulose, broadly (up to 2·5 cm.) sheathing. Blade above deep green (except the midrib), oblong-lanceolate or linear-lanceolate, inequilateral, 15-35 cm. long, 2-9 cm. broad, oblique at the base, acute or acuminate at the apex, midrib 3-5 mm. thick, very prominent on both sides, primary lateral nerves several on each side, scarcely prominent, passing away from the midrib at an acute angle. Peduncle very short, in fruit sometimes 5-6 cm. long; lower tube of spathe 1·5-2 cm. long, scarcely 1 cm. wide, upper tube 15-30 cm. long, 5-6 mm. wide, split at the apex, outside glabrous and dirty greenish, inside almost white, granulate towards the blade with many reddish papilli; blade ovate-oblong, 5-6 cm. long, 1·5-3 cm. broad, cuspidate, densely fimbriate with laciniæ 5-6 mm. long and slightly crisped, at the throat with a yellowish ovate spot about 2 cm. long, otherwise purple. Female inflorescence about 5-7-gynous, 1 cm. long, covered by an ovate process of the spathe and separated by an interval of almost 1 cm.; appendix shortly broad-conical, about 3 mm. long, 4 mm. thick below. Ovary 8 mm. long, several-seeded; ovules biseriate, narrowed into a short outward-bent style; stigma linear-oblong. Syncarpium ovoid-globose, 3-4 cm. wide, 5-7-sulcate and crowded with 5-7 remnants of the styles, 5-7-locular, valvately dehiscing; cells 3-8-seeded, germinating in the fruit.

Locality : Western Ghats (T. Cooke! Herb. Calc.).

Distribution : Mysore, Coromandel, Carnatic, Calcutta, Sunderbunds, Malay Peninsula and Archipelago.

9. **Cryptocoryne Dalzellii** Schott in Bonplandia v, (1857) 221 ; Engl. Pflanzenr. iv, 23F (1920) 248 ; Cke. ii, 819 (*sub specie dubia*).
Description : Imperfectly known : Blade of leaf lanceolate, epetiolate, apparently amplexicaul, the margin transparent and finally crenated ; veins parallel ; surface woolly as if covered densely with cobweb (Dalzell). Fruit ovoid, about 12 by 8 mm., on a solitary stalk ; seeds biseriate, oblong, subtrigonous.
Locality : 'Bombay' (Dalzell, Herb. Kew).

3. LAGENANDRA Dalzell.

Species 5.—India, Ceylon.

1. **Lagenandra ovata** (Linn.) Thwait. Enum. Pl. Zeyl. (1864) 334 ; Engler Pflanzenr. iv, 23F (1920) 228, fig. 57, 58.—*Arum ovatum* Linn. Sp. Pl. (1753) 967, ed. 2 (1763) 1371.—*Caladium ovatum* Vent. in Rœmer Arch. ii, (1801) 357.—*Cryptocoryne ovata* Schott Melet. i (1832) 6.—*Lagenandra toxicaria* Dalz. in Hook. Journ. Bot. iv, (1852) 289, v, (1853) t. 4 ; Dalz. and Gibs. Bomb. Fl. (1861) 257 ; Cke. ii, 819.
Description : Cke. 1 c.
Note : Leaves black in the shade, appressed to the ground (Sedgwick).
Locality : Konkan : In marshes (Dalzell) ; Bombay (Dalzell ! Herb. Calc.) ; Niwendi river bank, Ratnagiri Dist. (Garade ! Herb. Econ. Bot. Poona).—*S M Country :* Belgaum (Dalzell). *N. Kanara :* Yellapore (Talbot 1813 ! Herb. Econ. Bot. Poona) ; in streams and marshy places (Talbot 1012 ! Herb. Econ. Bot. Poona) ; in a stream above Malamani Ghat (Sedgwick and Bell 7201 !) ; Anmod, in nala (Sedgwick 3314 !) ; Arbail Ghat (Sedgwick 3459 !).
Distribution : From the Konkan to N. Kanara, Mysore, Coorg, Cochin, Travancore, Ceylon.
Flowers : Jan. and March (N. Kanara) ; May (Ratnagiri).
Fruit : Oct., Nov., Dec. (N Kanara).

4. ARISÆMA Mart.

Species 105.—Asia, Abyssinia, America.
Cooke has 4 species. We add 1 new to the Presidency : *A neglectum*, and describe a new species : *A. longecaudatum*.

A. Appendix of spadix not exserted beyond the spathe
  I. Leaflets sessile.
    (*a*) Appendix of spadix tapering from the base to the tip ... ... 1. *A. Murrayi.*
    (*b*) Appendix of spadix narrowly clavate ... 2. *A. Leschenaultii.*
  II. Leaflets petiolulate with thread-like tips. Spathe with a caudate tip.
    (*a*) Appendix 1·5 cm. long ... ... 3. *A. caudatum.*
    (*b*) Appendix 4 cm. long ... ... 4. *A. longecaudatum.*
B. Appendix of spadix far exserted beyond the spathe
  I. Leaves pedatisect ... ... 5. *A. tortuosum.*
  II. Leaves radiatisect... ... ... 6. *A. neglectum.*

1. **Arisæma Murrayi** (Graham) Hook. in Bot. Mag. (1848) t. 4388 ; Cke. ii, 821.
Description : We give a more complete description of this species from live material : Tubers hemispheric, up to 5 cm. diam., root-fibres crowded, arising from the upper side of the tuber, fleshy, white, rather tough. Sheaths broadly linear-oblong, or oblong-lanceolate, mucronate, lowest white, tipped purple, the others pale or dark purplish, the uppermost up to 30 cm. long, the lower much shorter. Leaf one, coming up shortly after the peduncle, but co-existent with the flower and finally reaching higher than the flower, peltate, glossy dark green on the upper surface, paler and shining beneath, divided to the base into 5-11 segments. Segments sessile, ovate-lanceolate-acuminate

or oblong-lanceolate-acuminate or obovate-lanceolate, cuneate at base, with 2 intramarginal nerves, the outer faint, the inner distinct and about 1 cm. from the outer, otherwise penninerved, the nerves from the midrib meeting the inner intramarginal nerve, all the nerves depressed on the upper surface and very prominent on the lower, the central one very pale green, margin either entire or dentate-sinuate and wavy, length from 6–15–45 cm., breadth 4–6-15 cm., acumen 1·5 cm. Petiole 30–90 cm. long, 2 cm. diam. below, 1 cm. near lamina (in a specimen 60 cm. high), cylindrical, striate, stout green or purplish-red or greenish-purple or green streaked with purple, sheathed for one half or less. Peduncle 30-90 cm., green or purple, cylindrical, thinner than the petiole, and slightly thinner towards the apex, shorter or longer than the peduncle. Spathe striate, up to 14 cm. long, tube cylindrical, 2·5–6 cm. long, 1–3 cm. wide, grass-green inside and outside with white striae, especially upwards, slightly constricted at top and there broadening into a broadly ovate-acute or ovate-acuminate, somewhat cucullate limb, limb up to 11 cm., incurved, sometimes at a right angle, at other times at 45° to the axis, pure white or sometimes with a green band or blotches along the centre, purple inside and outside where it meets the tube, the purple sometimes very faint or absent, especially outside, veins many, parallel, very distinct outside, faint inside, acumen mostly tinged with a bright green. Spadix narrowed from the base upwards, conical; appendage very variable 3–7 cm. long, greenish at base, becoming deep purple above and lighter in colour at the tip, exserted. (We have not seen it included in the tube), following more or less the bend of the limb, tapering to a fine point. Spadix androgynous or unisexual. Androgynous spadix : Female flowers below, crowded, covering about 2-3 cm. of the conical axis; ovaries arranged in many parallel spirals, sessile, style very short, stout, stigma disk-shaped, white; then follows an empty space of 3-4 mm. or the male flowers follow immediately, covering 1-2·5 cm. of the spadix, consisting of groups of 3–8, mostly 6 anther-lobes on a common very short stalk, sometimes a few subulate neuters above the anthers. Male spadix: Anther-bearing part up to 3 cm. long, 2--7, mostly 4 anther-lobes on a common stalk about 2 mm. long, globose or shortly ovoid, opening by a slit on top. Female spadix never seen. Ovaries when ripe, bright red, variously compressed.

Fruiting specimens showed the following measurements :

Tuber 8 cm. diam., whitish inside, producing young tubers from the upper side.

Petioles 80 cm. long ; leaflets 27 by 13 cm.

Fruiting inflorescence first green, then yellow and finally red, up to 8·5 cm. long, 3·5 cm. wide. Styles persistent.

There is usually 1 leaf to a plant, 2 are not uncommon, 3 are rare.

The anthers are faintly scented.—The plants with male spadices are generally only half the size of those with androgynous spadices.

Locality : Gujarat : Bandsa Hill S. W. of Surat (Law).—*Konkan* (Stocks); Ambenali (McCann !) Matheran (Cooke!).—*W. Ghats :* Khandala (McCann !, Sedgwick 2616 !, Bhiva !) ; Panchgani, very common (Blatter and McCann !) ; Mahableshwar, fairly common (Cooke !, Blatter !) ; Sinhagad (Woodrow) ; Igatpuri (McCann !) Purandhar (Bhiva !).—*Deccan :* Satara (Talbot 3385 !).

Distribution : Gujarat, Konkan, Deccan, W. Ghats, Nilgiris.

Flowers : July 1917 (Khandala), 7th July 1925 (Panchgani), 1st July 1925 (Panchgani), after first rains 1925 (Panchgani), Aug. 1894 (Satara).

Fruit : 25th Oct. 1917 (Igatpuri), Sept. 1917 (Igatpuri).

2. **Arisæma Leschenaultii** Bl. in Rumphia i, (1835) 93 ; Cke. ii, 821.—*A. Huegelii* Schott. Syn. 27; Prodr. 44.—*A papillosum* Steud. ex Schott Prodr. (1860) 46 ; Hook. in Bot. Mag. t. 5496, *excl. syn. erubescens.*

Description : Cke. ii, 821.

Locality : Cooke mentions the W. Ghats and the S. M. Country between Ramghat and Belgaum. He has not seen any specimens. We doubt the occurrence of this species in the Presidency.

Distribution : Nilgiris, Travancore, Ceylon.

3. **Arisæma caudatum** Engl. in. DC. Mon. Phan. ii, (1879) 559 ; Pflanzenr iv, 23 F. (1920) 183 ; Hook. f. F.B.I. vi, (1893) 508 ; Cke. ii, 822.

This is a species only partly known. Hooker f. (F.B.I. vi, 508) had seen no specimen and described it from a drawing by Stocks who had seen the plant in the Konkan. Engler described the species, as he says himself, from a badly dried specimen. We reproduce Engler's description which is more complete than either Hooker's or Cooke's. It may help future botanists to identify the plant in the field.

Description: Leaf solitary. Dioecious (Hooker and Cooke speak of the spadix as androgynous). Petiole stout, narrowly sheathed; blade radiatisect; segments 7, oblong-elliptic, long and very narrowly acuminate, ending in an aristiform 1–1·5 cm. long tip, shortly cuneate at the base, 15–17 cm. long, the middle segment 5 cm. broad, the lateral ones narrower, lateral nerves archingly ascending at an acute angle, 7–9 mm. distant from each other, united into an intramarginal nerve 2–3 mm. inside the margin. Peduncle much shorter than the petiole. Tube of spathe long-infundibuliform, 6–7 cm. long, above 2 cm. diam., margin of the throat slightly recurved, blade erect, oblong-lanceolate, about 8 cm. long, 3 cm. broad below, contracted into a narrow linear tail 8 cm. long. Inflorescence of spadix about 5 cm. long; appendix stipitate, thickened at the base; only 1·5 cm. long.

This plant has not been observed since Stock's time.

4. **Arisæma longecaudatum** Blatter in Journ. As. Soc. Beng. (1930) 362 (*per errorem langecaudata*).

Description: Whole plant reaching 1 m. and more, as a rule dioecious. Tuber depressed-globose; root-fibres numerous, from the upper side of the tuber, less tough than in *A. Murrayi.* Leaf solitary, peltate; petiole stout, straight, up to 60 cm. long, cylindric, smooth, shining, green and purple-marbled; leaflets generally 6, whorled, petiolulate with petiolules 5 mm. long, very variable even in the same leaf, obovate-cuneate or broadly lanceolate or oblong-lanceolate, all caudate-acuminate, with acumination up to 4 cm. and capillary towards end, dark green above, paler beneath, shining, up to 22 cm. by 9 cm., intramarginal veins 2, nerves depressed above, prominent beneath. Peduncle up to 40 cm. cylindric, thinner than petiole, of the same colour, but green near top. Male spathe up to 30 cm. long, grass-green throughout, striped externally with white; tube elongate-cylindric, up to 8 cm. long, 2 cm. diam., widening into an ovate-lanceolate, long caudate-acuminate limb, 7 cm. long (without acumen) and 4 cm. broad, slightly reflexed near the tube, acumen 13 cm. long; limb deflexed, pendulous. Male spadix up to 9 cm. long, exserted from the tube for 1 cm., conical in the flower-bearing part which is about 5 cm. long, appendix about 4 cm. long, straight, slightly thickened at the base, then more or less uniformly cylindric, blunt at tip. Stamens white; filaments stout, about 2 mm. long, usually 3 united carrying 6, sometimes 7–8 anther-lobes which are shortly ovoid or globular. Female spathe up to 45 cm., tube 10 by 2·5 cm., limb (without acumen) 13 by 6 cm., acumen 22 cm. Female spadix: Flower-bearing part about 5·5 cm. long, above female flower some neuters for 5 mm., appendix 4 cm. long, like male. Female flowers arranged in many parallel dense spirals. Ovaries spherical or shortly oblong, green, unilocular. 1–3-ovuled; style very short, stout, green, stigma disk-like, white, covered with crystalline protuberances. Neuters above the female flowers up to about 17, subulate.

Here are a few measurements of a plant in fruit taken towards the end of August 1930 at Mahableshwar.

Leaflets (including tail) 43 cm. by 12·5 cm. Fruiting spadix up to 14 cm. long, 4·5 cm. diam. below, conical, some neuters persisting at top of cone. From the upper side of the tuber several young tubers arise. Tuber whitish green inside. Some fruiting specimens growing in rock-crevices at Panchgani had the petioles 1·2 m. in length, and peduncles 95 cm. long.

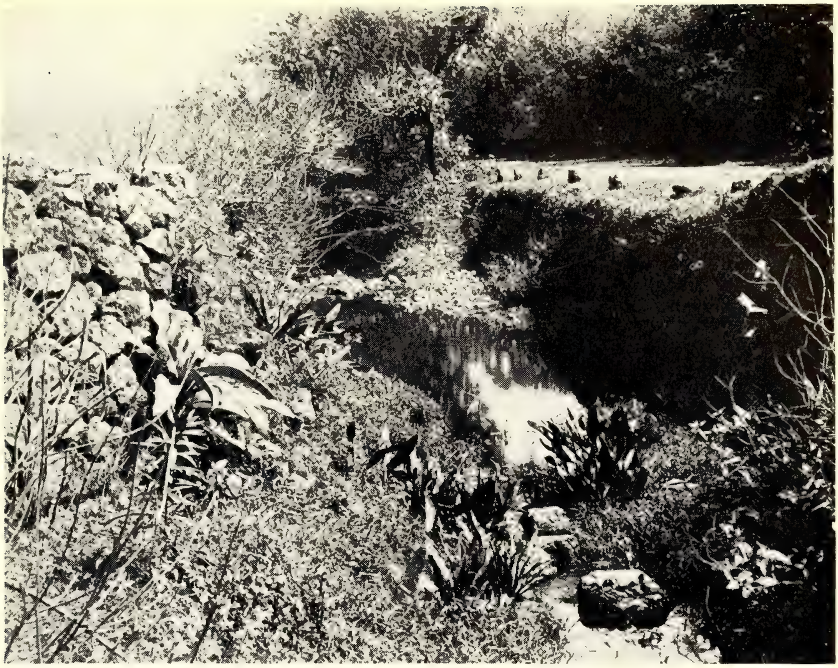
Abnormalities: In a female spadix (call it incipient or atavistic androgynous spadix) were noticed above the female flowers 2 male flowers, each consisting of 2 filaments united below and free above, each filament with 2 distinct white anther-lobes separated from each other by a broad green connective.

Mixed with the neuters of a female spadix the following were observed:

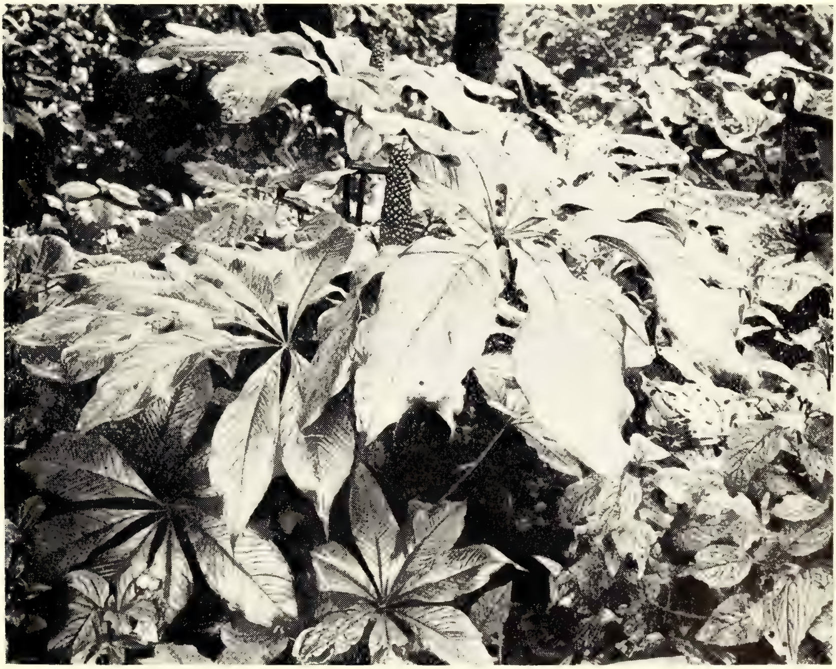
(*a*) One bisexual flower on 2 pedicels united at the base: one pedicel bearing an undeveloped ovary and well-developed style, the other pedicel one complete anther.

(*b*) Some male flowers: 1 filament with an anther-lobe.

(*c*) Some male flowers: 1 filament with a complete anther and connective.



1. Cryptocoryne tortuosa, Blatter & McCann, sp. nov.
(*In foreground near water*).



2. Arisæma longecaudatum, Blatter & McCann, sp. nov.
(*Photos by C. McCann.*)

Flowers and leaves seen at the same time. Spathe usually reaching to up below the leaf, the leaf thus protecting the flower ; the spathe is never higher than the leaf. The spathes turn pale and then yellow.

Locality : Mahableshwar, very common (Blatter P. 10 !, P. 10*a-e* !, McCann!); Panchgani, very rare, only found in a few rock crevices (Blatter !, McCann !, May Langham !).

5. **Arisæma tortuosum** (Wall.) Schott Melet. i, (1832) 17 ; Hook. f. F.B.I. vi, (1893) 502 ; Cke. ii, 820.—*Arum tortuosum* Pl. As. Rar. ii, (1830) 10.

Description : Cke. ii, 820.

This is a most variable plant regarding the size, number and breadth of the segments. The inflorescence of the spadix may be monoecious or dioecious. The proportion of the male and female inflorescences, too, varies a good deal in the androgynous spadices. The length of the appendix and the colour of the spathe are not constant either.

Locality : Konkan (Stocks).—*W. Ghats :* Khandala (Chibber!).—*S. M. Country :* Tavargatti (Sedgwick 2632 !, 2643 !).—*N. Kanara :* Karwar (Talbot 514 !, Bell 6107 !).

Distribution : Chamba, Garhwal, Nepal, Sikkim, Khasia Hills, Burma, Central Provinces, Nilgiris.

Flowers : June 1883 (Karwar), June 1907 (Khandala), July (S. M. Country). Fruit : Oct. (Karwar).

6. **Arisæma neglectum** Schott in Bonplandia vii, (1859) 26 ; Hook. f. F.B.I. vi, (1893) 504 ; Engler Pflanzenr. iv, 23 F. (1920) 192, fig. 43.—*A. filiforme* Thw. Enum. (1864) 334 (*non* Blume).—*A. Wightii* Bot. Mag. (1865) t. 5507 (*non* Schott).

Description : Leaves 2 or 1. Monoecious or dioecious. Tuber globose, young plants budding off from it. Cataphylls tubular below, above broadly linear, obtuse, obscurely spotted like the sheaths of the petioles, the uppermost about 15 cm. long. Petioles 20–40 cm. long, sheathed up to the middle or far beyond it ; lamina 5- (sometimes 4-) to 7-radiatisect, segments elliptic or lanceolate-elliptic or lanceolate, shortly cuspidate-acuminate, cuneate at the base, sessile, with undulate margin, the intermediate one up to 10 cm. long or slightly longer, in the middle 4 cm. broad, the lateral ones slightly smaller, lateral nerves 5–7 mm. distant from each other and united into an intramarginal nerve 3-4 mm. away from the margin. Peduncle longer than the petioles, 30–40 cm. ; tube of spathe pale green, cylindrical, 2-3 cm. long, throat slightly constricted with the margins subrevolute, lamina green, with lighter longitudinal stripes, ovate- or oblong-lanceolate, 5-6 cm. long, 2 cm. broad, long acuminate. Spadix of unisexual or androgynous inflorescence about 2 cm. long, green or dark purple, conical ; appendix as thick below as the axis of the inflorescence, getting thinner upwards, sigmoidally curved. Male flowers subsessile, with 2-3 stamens ; anther-lobes ovoid, dehiscing by a longitudinal slit.

Locality : Konkan : Hills N.-W. of Mullaud, Salsette, in deciduous forests (McCann 1643 !, 1644 !, 1645 !, 1646 !, 1647 !, 1648 !, 1649 !).—*N. Kanara* (Talbot 514 !, 1258 !).

Distribution : Konkan, N. Kanara, Nilgiris, Ceylon.

5. TYPHONIUM Schott (Cke. ii, 822).

Species 25.—Indo-Malayan.

Cooke mentions 2 species : *T. bulbiferum* and *T. cuspidatum.* We add *T. amboinense* and *T. trilobatum* and describe a new species. *T. cuspidatum* has to cede to *T. flagelliforme.*

I. Lower rudiments of sterile flowers clavate, upper ones subulate or only verruciform ... ...
1. Spathe more or less straight and upright ... 1. *T. flagelliforme.*
2. Spathe bent downwards above the tube ... 2. *T. incurvatum.*
II. Rudiments of sterile flowers never clavate.
1. Leaves bulbiferous at the apex of the petiole. 3. *T. bulbiferum.*
2. Leaves not bulbiferous ... ...
(*a*) Appendix of spadix red or red-fulvous, very shortly or scarcely stipitate ... 4. *T. trilobatum.*
(*b*) Appendix of spadix black-purple, longer stipitate ... ... 5. *T. amboinense.*

1. **Typhonium flagelliforme** (Lodd.) Bl. in Wall. Cat. (1832) 8931; Engl. Pflanzenr. iv, 23 F (1920) 112, fig. 16.—*Arum flagelliforme* Lodd. Bot. Cab. (1819) t. 396; Roxb. Fl. Ind. iii, (1832) 502; Wight. Ic. iii, (1843) t. 791.—*Heterostalis flagelliformis* Schott in Österr. bot. Wochenbl. vii, (1857) 261, Gen. Ar. (1859) t. 18.—*Arum cuspidatum* Bl. Cat. Gew. Buitenz. (1823) 101.—*Typhonium cuspidatum* (Bl.) Decaisne Herb. Timor in Ann. Hist. Nat. iii, (1834) 39; Bl. Rumphia i, (1835) 133. t. 30, f. 1–3; Hook. f. F.B.I. vi, (1893) 511; Cke. ii, 823.—*Nelenshena major* Rheede Hort. Mal. ii, (1679) t. 20.—*Arum angulatum* Griff. Notul. iii, (1831) 143.—*A. ptychiurum* Zipp. ex Kunth Enum. iii, (1841) 26.—*Typhonium hastiferum* Miq. Fl. Ind. Bat. iii, (1855) 194.—*T. Reinwardtianum* de Vriese *et* Miquel Fl. Ind. Bat. iii, (1855) 195.

Description: Cke. ii, 823.—A correction is necessary. Cooke says that the neuters above the male inflorescence are subulate. It should read below the male inflorescence, as there are no neuters above it.

Hook. f. (F.B.I. vi, 512) calls the spathe 'lurid red, papillose within.' Hallberg notes that in the plant from Parel the spathe was green and not papillose. Engler says that the tube of the spathe is green and the limb white.

We found the ovaries whitish (Cooke greenish), the lower neuters pale green with chocolate bifid tips (Cooke purple headed), the upper neuters whitish, the stamens yellow, the appendix of the spathe olive green or yellowish.

Locality: Konkan: Parel in Bombay Isl. (Ranade!, Cooke!, Hallberg!); Salsette (Hallberg!).

Distribution: Konkan, Travancore, Ceylon, Bengal, Burma, Malay Peninsula, Cochin-China, Laos, Cambodia, Tonkin, Java, Timor.

Flowers: Aug., Sept. 1892 (Parel).

2. **Typhonium incurvatum** Blatter & McCann, *sp. nov.* [*Araceæ*].

Tuber globosus, vix depressus, 3 cm. diametiens. Foliorum petioli tenues, canaliculati, ca. 20 cm. longi, basi equitantes; lamina viridis supra, pallidior infra et glauca, forma et magnitudine variabilis, sagittata vel hastato oblonga, a basi cordata et triloba, usque 10 cm. longa, medio 5 cm. lata, nervi depressi in facie superiore, prominentes in inferiore, lobi basales valde variabilis, absentes vel usque 2·5 cm. longi et 2 cm. lati. Pedunculus 3 mm. crassus, 7 cm. longus; spathae tubus viridis, ovoideus, superne profunde constrictus, 2 cm. longus; lamina dilute viridis, ovata, circa inflorescentiam masculam et appendicem sursum incurvata, transversaliter saccata, in flagellum 8 cm. longum et 4 mm. latum prolongata, apice acuta, a basi 5-nervosa, nervo centrali in apicem excurrente. Spadix ca. 5 cm. longa; inflorescentia feminea 6 mm. longa, cylindrica, alba florum sterilium inferiorum rudimenta claviformia apice depressa, purpurea, ca. 2 mm longa, superiorum subuliformia, deflexa, albida; feminea inflorescentia a mascula interstitio ca. 13 mm. longo separata; inflorescentia mascula cylindrica, 5 mm. longa, 2·5 mm. diametiens, flava. Spadicis appendix brevissime stipitata, inferne constricta, elongato conoidea (minimem filiformis), 2·7 cm. longa, flavescens. Pistilla ovoidea, apiculata. Inflorescentia feminea in fructu elongato-ovoidea, cooperta spathae tubo permanente, quadrangularis. Pedunculus elongatus. Bacca oblongo-obovoidea, monosperma. Semen oblongum, aliquantulum latius in parte superiore, rugulosum, apice apiculatum.

Locality: Konkan: Sion in Bombay Isl., foot of W. slope of hill (McCann 998! type, 999! 1000!, 1001! co-types).

Flowers and Fruit: 25th Aug. 1929.

3. **Typhonium bulbiferum** Dalzell in Kew Journ. Bot. iv, (1852) 113; Hook. f. F.B.I. vi, (1893) 511; Cke. ii, 822; Engler Pflanzenr. iv, 23 F. (1920) 116, fig. 15 S–V.

Vern. name: Rantiri.

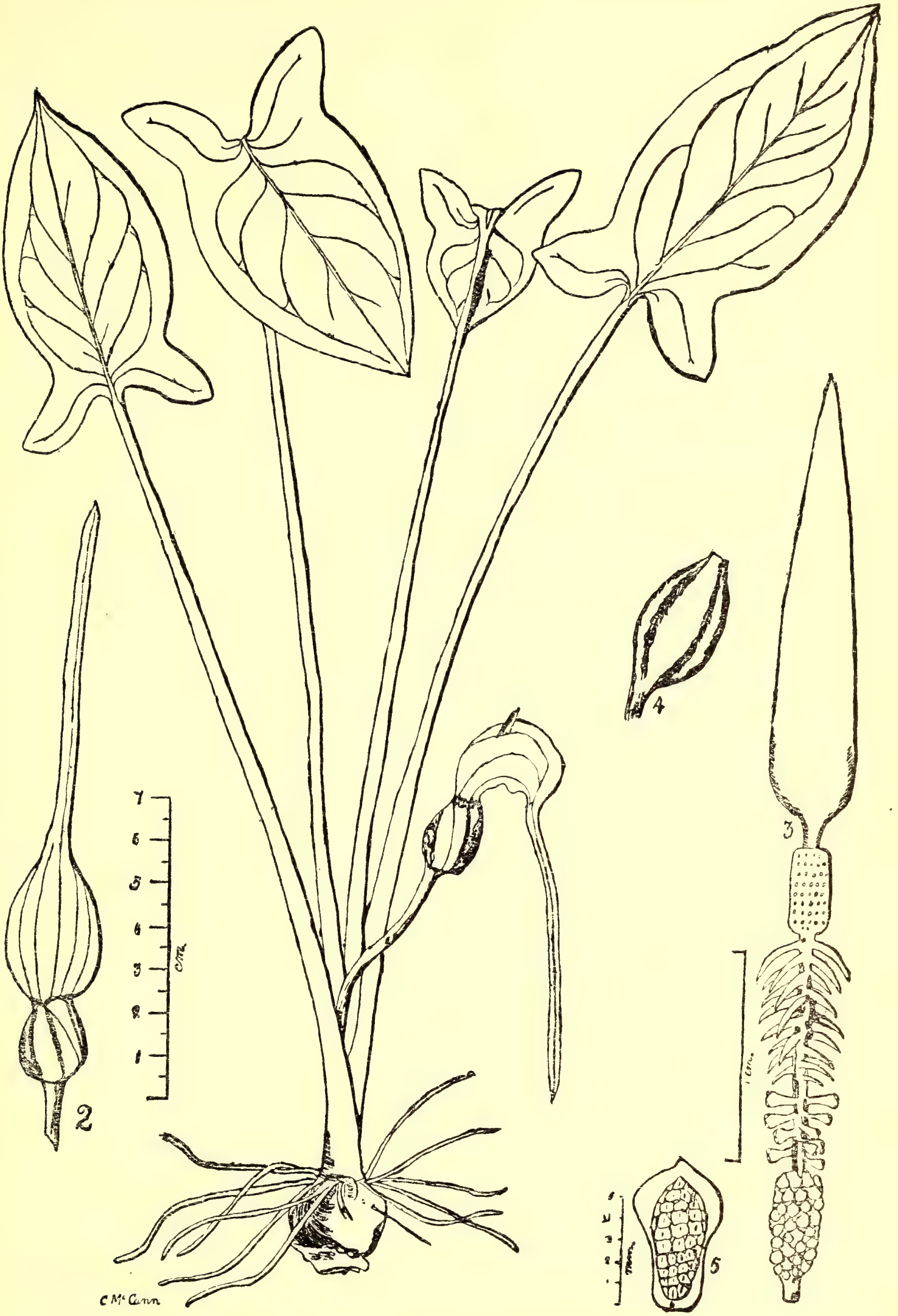
Description: Cke. ii, 822.

Locality: Konkan: (Stocks); Kalyan (Garade!); Roha (Damle 539!).—*S. Konkan* (Dalzell).—*S. M. Country:* Tavargatti, in shade of trees (Sedgwick 2618!).

Distribution: Apparently endemic.

Flowers: June 1902 (Roha); July 1905 (Kalyan); July 1917 (S.M. Country).

4. **Typhonium trilobatum** (Linn.) Schott in Wien. Zeitschr. iii, (1829) 72; Aroid. i, (1853) 12, t. 16.—For synonyms, see Hook, f. F.B.I. vi, 509,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Typhonium incurvatum, Blatter & McCann, sp. nov.

1. Plant. 2. Spathe. 3. Spadix. 4. Fruit. 5. Bacca.

Description : Tuber subglobose, up to 4 cm. diam. Petioles 25–30 cm. long, often surrounded by a variegated sheath, pale green, irregularly mottled with purple ; lamina hastate-subtrisect, segments all acuminate, front-segment ovate, 8–18 cm. long, 5–10 cm. broad, lateral ones obliquely ovate, shorter, sub-bilobed at base. Peduncle thin, 5–7 cm. long ; tube of spathe oblong, 2·5 cm. long, 1–1·5 cm. wide, lamina oblong-ovate-lanceolate, acuminate, 15 and more cm. long, 5–7 cm. broad, outside pale green, inside rose-purple. Spadix nearly 15 cm. long. Female inflorescence short-cylindric, about 7 mm. long ; rudiments of sterile flowers filiform, flexuose, almost 1 cm. long, occupying a space of about 7 mm. long immediately above the female flowers. Male inflorescence about 1·25–1·5 cm. long, 5 mm. diam., rose-pink, separated from the female inflorescence by an interval of about 2 cm. Appendix very shortly stipitate, broad at the base, 4–7 mm. diam., elongate-conical, about 5–12 cm. long.

Locality : Bombay Pres. (Graham).

Distribution : W. Peninsula, Ceylon, Bengal, Burma, Assam, Chittagong, Malay Peninsula, Siam, Cambodia, Tonkin, Java, Borneo.

5. **Typhonium amboinense** Blatter & McCann, *nov. comb.—Arisarum amboinense* Rumph. Herb. Amb. v, (1747) 320, t. 110, f. 2.—*Arum Roxburghii* Thwait. Enum. Pl. Zeyl. (1864) 432.—*Typhonium Roxburghii* Schott Aroid. i, (1855) 12 (excl. t. 17) ; Saunders Ref. Bot. (1871) t. 283 ; Hook. f. F.B.I. vi, (1893) 510 ; Engl. Pflanzenr. iv, 23 F. (1920) 119, fig. 17, C. D.—*Arum trilobatum* Roxb. Fl. Ind. iii, (1832) 505 ; Wight Ic. iii, (1843) t. 803 ; Bot. Mag. t. 339.—*Typhonium javanicum* Miq. Fl. Ind. Bat. iii, (1855) 193.—*T. divaricatum* γ *et* δ. Engl. in DC. Mon. Phan. ii, (1879) 612.

Description : Tuber subglobose. Petioles thin, 10–35 cm. long, lamina hastate-3-lobed or hastate-subtrisect, segments shortly acuminate, middle segment ovate, 5–9 cm. long, 3–4 cm. broad, lateral ones obliquely ovate or obliquely oblong-ovate, sometimes lobed-dilatate on the outer side below. Peduncle thin, 2–9 cm. long ; tube of spathe oblong, 2 cm. long, 1 cm. wide, lamina ovate-lanceolate, acuminate, up to 15 cm. long, below 5 cm. broad, outside pale, inside dark purple-violet. Female inflorescence of spadix shortly cylindric, about 4 mm. long ; rudiments, of sterile flowers filiform, flexuose, about 5–6 mm. long, deflexed, occupying 5 mm. immediately above the female inflorescence, about 1 cm. long, 5 mm. wide, separated from the female inflorescence by an interval of 1·2–1·5 cm. Appendix of spadix thinly stipitate, at the base 3-4 mm. diam., elongate-myosuroid, 10-12 cm. long. Stamens 2-3. Pistils obovoid ; stigma sessile.

Locality : Konkan : Bombay Isl., coconut groves at Dadar, especially in sandy soil (Blatter !).—*W. Ghats :* Panchgani, in rock crevices (McCann 2781 !).

Distribution : Ceylon, Konkan, W. Ghats, Malay Peninsula, Borneo, Philippines, Java.

Flowers : July (Bombay).

Species dubia.

Graham [Cat. Bomb. Pl. (1839) 228] mentions *Arum divaricatum* Linn., which had been included by Roxburgh in his Fl. Ind. iii, (1832) 503. But there is a difficulty about the identity of *A. divaricatum* Linn. Linné [Sp. Pl. (1753) 967] refers under *A. divaricatum* to the Fl. Zeyl. no. 325. As, however *Typhonium divaricatum* (Linn.) Decaisne has not been found in Ceylon, Trimen (Handb. Fl. Ceyl. iv, 354) suspects that *A. divaricatum* Linn. belongs either to *Typhonium Roxburghii* (our *T. amboinense*) or to *T. cuspidatum* (now *T. flagelliforme*). As there are no original specimens in Hermann's herbarium, it is impossible to say what Linné's *A. divaricatum* really is.

6. THERIOPHONUM Blume (Cke. ii, 823).

Species 6.—Indian.

Cooke has one species ; *T. Dalzellii* Schott. We add *T. minutum* Engl. and describe a new one. *T. Dalzellii* has to be changed into *T. indicum* Engl.

A. Lower and upper rudiments of sterile flowers near the male flowers ... ... 1. *T. minutum.*

B. Lower rudiments of sterile flowers near the female flowers
  I. Pistils sub-4-seriate ... ... 2. *T. indicum.*
  II. Pistils uniseriate ... ... 3. *T. uniseriatum.*

1. **Theriophonum minutum** (Willd.) Engl. Pflanzenr. iv, 23 F. (1920) 105.—*Arum minutum* Willd. Sp. Pl. iv, (1805) 484; Graham Cat. Bomb. Pl. (1839) 228.

Description : Tuber small, depressed, 1–2 cm. diam. Petioles 5–15 cm. long, narrowly sheathed up to the middle or beyond and pale rose coloured or fusco-punctate, above the sheath green; lamina hastate-triangular, subtrilobous, with the margin undulate, about 3–5 cm. long, front-lobe twice as long as the lateral ones, 2·5 cm. broad, all lobes sub-obtuse or shortly acuminate. Peduncle 3–10 cm. long; spathe whitish; tube about 1–2 cm. long, obtuse at the base or subtruncate; lamina oblong, subacute or shortly cuspidate, about 7–9 cm. long, 3–3·5 cm. broad, red, with the margin crisped-crenulate. Female inflorescence few-flowered; pistils subbiseriate; male inflorescence thinly cylindrical, 1–1·5 cm. long, separated from the female inflorescence by a naked interval of 2–4 mm. Rudiments of sterile flowers thin, subulate, 2–4 mm. long, occupying about 4 mm. at the base of the male inflorescence, others shorter, 1-2 mm. long, occupying 5–8 mm. above the male inflorescence, lilac like the male flowers. Appendix subcylindrical, about 1·5–3·5 cm. long, stouter below (3-4 mm. diam.), above slightly thinner, obtuse, black purple.

Var. Heynei, Engl. in DC. Mon. Phan. ii, (1879) 607; Pflanzenr. iv, 23 F (1920) 105, fig. 2, R and 15 A.F.—*Arum crenatum* Wight in Hook. Bot. Misc. ii, (1831) 100; Suppl. t. 3; Graham Cat. Bomb. Pl. (1839) 228.—*Typhonium crenatum* Schott Melet. i, (1832) 17.—*Theriophonum crenatum* Bl. in Rumphia i, (1835) 128; Schott Aroid. i, (1853) 15, t. 21; N. E. Brown in Journ. Linn. Soc. xviii, (1880) 259. *excl. syn. T. Kleinii* Schott; Hook. f. F.B.I. vi, (1893) 512 *excl. syn. T. Kleinii.*

Description : A taller plant. Petioles up to 15 cm. long; lamina about 5 cm. long. Tube of spathe subtruncate at the base, up to 2 cm. long; lamina oblong, about 9 cm. long. Lower rudiments of sterile flowers forming a spike as long as the female inflorescence, the upper rudiments together with the fertile male flowers forming a spike as long as the female inflorescence. Connective of stamen shortly rostrate.

Locality : Bombay Pres. (Graham).

Distribution : Madras, Coromandel coast.

Var. Kleinii, Engl. in DC. Mon. Phan. ii, (1879) 607.—*Arum minutum* Willd. Sp. Pl. iv, (1805) 484; Grah. Cat. Bomb. Pl. (1839) 228.—*Typhonium minutum* Bl. in Rumphia i, (1835) 134.—*Theriophonum Kleinii* Schott in Öesterr. bot. Zeitschr. viii, (1858) 3.—*T. crenatum* Schott Aroid. i, (1855) 15, t. 21.—*Nelenschena minor* Rheede Hort. Malab. xi, (1692) 33, t. 17.

Description : A smaller plant. Petioles 5 cm. long; lamina about 4 cm. long. Tube of spathe ovate, about 1 cm. long; lamina about 7 cm. long. Lower rudiments of sterile flowers forming a spike shorter than the female inflorescence, the upper rudiments together with the fertile male flower forming a spike about 6 times as long as the female inflorescence. Connective of stamens shortly rostrate.

Locality : Bombay Pres. (Graham).

Distribution : W. Peninsula of India. No definite locality.

2. **Theriophonum indicum,** (Dalz.) Engl. in Pflanzenr. iv, 23 F. (1920) 107.—*Tapinocarpus indicus* Dalz. in Hook. Journ. Bot. iii, (1851) 346.—*Theriophonum Dalzellii* Schott Aroid. i, (1853) 15), Syn. (1856) 21; Engl. in DC. Monogr. Phan. ii, (1879) 608; Hook. f. F.B.I. vi, (1893) 513; Cke. ii, 823.—*Tapinocarpus Dalzellii* Schott. Gen. Ar. (1859) t. 15.

Description : Tuber about 2 cm. diam. Leaves appearing with the flowers or a little in advance of them. Petiole 20–25 cm. long, vaginate for the third or fourth part of its length; lamina up to 20 cm. long, variable in breadth, elliptic, oblong or linear, acute or subobtuse, smooth and shining above, dull beneath, base rounded or hastate, or sagittate, front-lobe ovate-oblong to oblong, 4–5 cm. broad, lateral lobes oblong, usually only 3 leaves. Peduncle up to 20 cm. long, in fruit twisted and curved to the ground. Tube of spathe subtruncate at the base, oblong, green when young, soon fading to white, 3 cm. long, 1·5 cm. wide; lamina lanceolate-oblong, long-acuminate, deep purple, rapidly fading, 15 cm. long, 2·5 cm. broad. Female inflorescence short, pistils sub-4 seriate, separated from the male inflorescence by an interval of 2·3-3cm.; male inflorescence about 7 mm. long; rudiments of sterile flowers near the pistils, thinly subulate, about 4 mm. long, greenish yellow, a few short subulate rudiments above the male inflorescence and close to it. Anthers rosy purple. Ovaries whitish, with greenish yellow hairs on top, stigma purple-pink. Appendix of spadix deep crimson or purple, when young greenish yellow above, thinly cylindrical, about 15 cm. long, 1·5 mm. thick. Ovules 4-6, of which 1-3 are pendulous from the top of the cell of the ovary, the remaining ones basal, erect. Fruit angular, 4-5-seeded.

According to McCann the young leaves are entire, cordate, ovate or almost round, acuminate.—The tuber produces a number of young tubers from the upper side.

Locality: Konkan (Stocks, Dalzell); Vengurla (Dalzell); moist grassy places in S. Konkan (Dalzell and Gibson); Kalyan (Woodrow!); hill N.-W. of Bhandup, under shrubs and in open along aqueduct (McCann 694!, 695!); Bhandup (Blatter and McCann 26381!, 26384!).—*N. Kanara:* Karwar (Talbot 85!, 1890!).

Distribution: Apparently endemic.

Flowers: June 1917, July 1929 (Bhandup); June 1883, Aug. 1889 (Karwar).

3. **Theriophonum uniseriatum**, Blatter & McCann, *sp. nov.* [*Aracea, accedens ad T. indicum* Engl., *a quo tamen differt pistillis uniseriatis, florum sterilium rudimentis 1 cm. ab inflorescentia feminea remotis, aliis rudimentis absentibus, inflorescentia mascula multo longiore*].

Tuber circa 2 cm. diametiens. Folia cum floribus coaetanea. Foliorum petiolus usque 25 cm. longus. Lamina usque 16 cm. longa et 15 cm. lata ubi latissima, late ovata et irregulariter hastata vel oblongo-cordata. Pedunculus crassus, usque 13 cm. longus. Spatha usque 20 cm. longa; tubus pallide viridis quando juvenis, basi convolutus; lamina oblongo-lanceolata, intus nigro-purpurea, extus olivacea. Spadicis inflorescentia feminea brevis, ca. 5 mm. longa, obovoidea, pallide viridis; pistilla uniseriata; stigma latum pilis minutis crystallinis coopertum. Florum sterilium rudimenta plura 1 cm. ab inflorescentia feminea remota, tenuiter subulata, erecta vel ascendentia, 3-4 mm. longa, flavo-brunnea, alia rudimenta nulla. Inflorescentia mascula 2 cm. altius in spadice posita, 12 mm. longa; antherae roseo-purpurascentes, thecis poro apicali aperientibus. Axis inter flores femineos et steriles rubro-purpurea inter steriles et masculas nigro-purpurea. Appendix teres, elongata, non stipitata, versus apicem attenuata, 8 cm. longa, basi 3 mm. diametiens, flava quamdiu inclusa in spatha, deinde purpurea.

Locality: N. Kanara: Karwar (T. R. D. Bell 1666!).

Flowers: End of July 1924.

7. SAUROMATUM Schott (Cke. ii, 824).

Species 4.—Palæotropics.

1. **Sauromatum guttatum** (Wall.) Schott Melet. i, (1832) 17; Hook. f. F.B.I. vi, (1893) 508 emend.; Cke. ii, 824; Engl. Pflanzenr. iv, 23 F (1920) 123, fig. 18 A-L.—*Arum guttatum* Wall. Pl. As. Rar. ii, (1831) 10, t. 115.—*Sauromatum simlense* Schott in Osterr. bot. Zeitschr. viii, (1858) 263.—For further synonyms see Hook. f. *l.c.*

Description: Tuber very large, globose, up to 15 cm. diam., producing buds from the top and sides. Leaf solitary. Petiole up to 50 cm. long, very stout at the base, up to 2 cm. diam., attenuate upwards, spotted or not; lamina in outline rotund-cordate, pedate-palmate to pedatifid or pedatisect; segments oblong or oblong-lanceolate, acuminate, the intermediate one up to 25 cm. long, 15 cm. broad, the lateral ones on each side 3-7, getting gradually smaller; primary lateral nerves about 5-6 on each side, distant from each other 1-1·5 cm., and secondary parallel nerves united into an intramarginal nerve 2-3 mm. from the margin. Peduncle measuring scarcely 5 cm. beyond the cataphylls and 2 cm. diam., pale green, cataphylls few, soon withering, 5-10 mm. long, triangular, acute, broad at base. Spathe large, very variable in size; tube 5-10 cm. long, slightly ventricose below, above subcylindric, about

2-2·5 cm. wide; lamina in æstivation convolute into a purple-livid cylinder which is tumid at the base, then straight-ascending and slender acuminate, when expanded oblong-lanceolate, very large, 30-70 cm. long, 8-10 cm. broad, lower margin irregularly sinuate-repand, upwards gradually narrowed into an acumen, purple below, light green in the middle and above, often with angular dark purple spots or blotches, finally recurved from the middle, descending and touching the ground. Spadix about $\frac{1}{3}$ shorter than the spathe. Female inflorescence cylindric, about 2-2·5 cm. long, 1·5 cm. diam.; rudiments of sterile flowers stipitate-claviform, spreading, inserted immediately above the female flowers; male inflorescence 1·5 cm. long, distant from the female inflorescence by an interval of about 6 cm. which bears some scattered minute, acute, aculeiform rudiments; appendix cylindric, obtuse, about 30 cm. long, 1 cm. diam., pale fuscous or purplish. Pistils very numerous, small, obovoid, subtruncate at top, 2-ovulate. Stamens with very short filaments.

Note: Sometimes only the central leaflet develops.

Hallberg found a specimen at Bandra (July 1917) with two quite green leaves, one sheathed by the other. The inner one was the larger and showed a central channel in which there was a thick laminar outgrowth, probably the remains of the free basal margin of the leaf. Inside the channel there was a leaf-embryo with a thick conical petiole and a minute bifid lamina which was decomposing. The whole may have been due to the leafing of the peduncle, the second leaf being the spathe and the third a carpel.

For some biological notes on this species and a good illustration of the leaf we refer to C. McCann in this Journal, vol. xxxiv, (1930) 518, fig. 1.

Locality: Gujarat: Surat (Herb. R. E. P. Calcutta 20,332).—*Konkan:* (Stocks); Versova (Blatter & McCann 26373 !); Thana Dist. (Ryan); Bhandup (Blatter & McCann 26383 !); Sion Hill (McCann 995 !); Uran (Hallberg and McCann !); Salsette (McCann !). *Deccan:* Junnar (Paranjpye !). —*W. Ghats:* Panchgani (Blatter P 22 !); Lonavla (Woodrow !); Khandala (Blatter & McCann !). *S. M. Country:* Astoli (Sedgwick 2624 !).

Distribution: Punjab, Gangetic Plain, Himalaya from Simla to Nepal, Chota Nagpur, Gujarat, Konkan, Deccan, W. Ghats, Burma, Sumatra.

Flowers: Jan. 1917 (Uran); March 1911 (Junnar, Thana, Bhandup); June 1917 (Bhandup, Panchgani); July 1925 (Panchgani).

Fruit: Sept. 1917 (Versova).

8. AMORPHOPHALLUS Blume (Cke. ii, 825).

Species about 90. Tropical Asia and Africa.

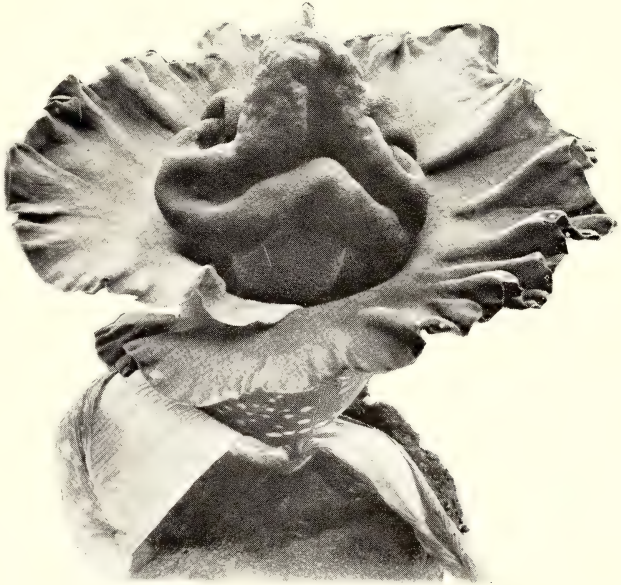
Cooke gives 3 species: *A. bulbifer*, *A. campanulatus*, and *A. commutatus*. We add *A. silvaticus* and *A. Hohenackeri.*

A. Leaves not bulbiferous
    I. Spathe greenish pink, 15-25 cm. broad; appendix irregularly amorphous, dark purple ... ... 1. *A. campanulatus.*
    II. Spathe brownish purple, 5-10 cm. broad, appendix terete, smooth, cream-coloured ... ... 2. *A. commutatus.*
    III. Spathe white inside, outside green, white-striate, towards the margin white-spotted, 3 cm. broad; appendix elongate-conical, pale straw-coloured, flexuose ... . 4. *A. silvaticus.*
    IV. Spathe 3 cm. broad; appendix 3·5-4 cm. long, 1·5 mm. diam., elongate, thin, subulate, straight ... ... 5. *A. Hohenackeri.*
B. Leaves bulbiferous ... ... 3. *A. bulbifer.*

PLATES V & VI.

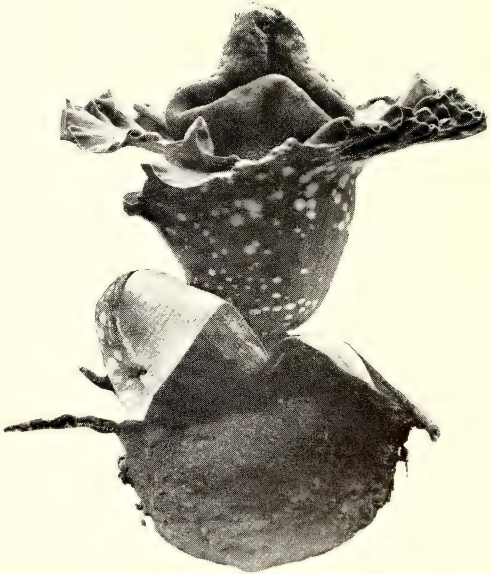
1. **Amorphophallus campanulatus,** (Roxb.) Bl. in Decne in Nouv. Ann. Mus, Par. iii. (1834) 366 *excl. syn. praeter* Roxb.; Cke. ii, 825; Engler Pflanzenr. iv. 23C (1920) 76. For synonyms see Hook. f. F.B.I. vi, (1894) 513.

Description: Cke ii, 825. A more complete description by Khadilker in Journ. Ind. Bot. ii, (1921) 55.



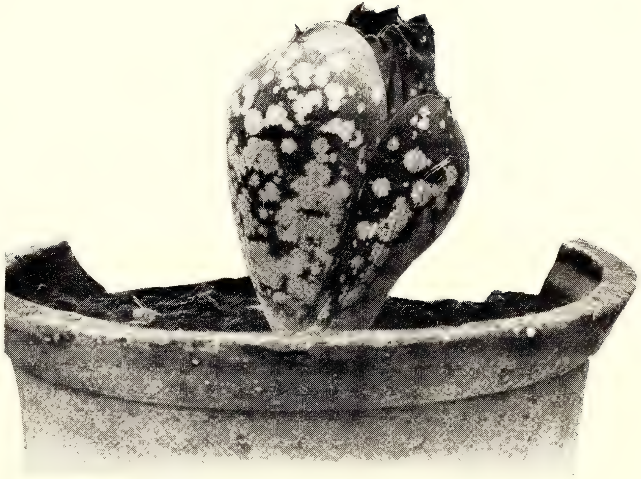
1. Open flower of *Amorphophallus campanulatus*, Blume.

(*4 days later than Pl. VI, 1*).

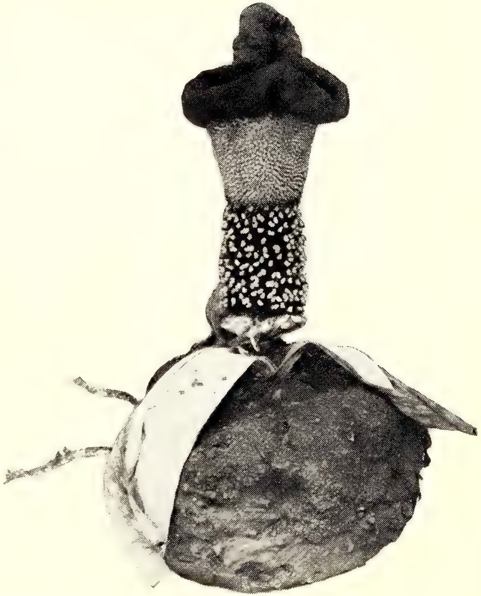


2. Open flower of *Amorphophallus campanulatus*, Blume.

(*Photos by C. McCann.*)



1. Bud of *Amorphophallus campanulatus*, Blume.



2. Spadix of *Amorphophallus campanulatus*, Blume.

(*Photos by C. McCann.*)

For biological notes see McCann in this Journal, vol. xxxiv, (1930) 520.

Cataphylls usually 2, greenish, obovate, tip emarginate, apiculate, about 13 cm. long.

The bad smell is restricted to the appendix of the spadix (McCann).

Appendix of spadix crimson lake when fresh, turning purple and eventually deep brown. Colour of spathe very variable, but usually has large whitish blotches.

Locality : Konkan : Borivli to Kanari Caves (McCann 1638 !) ; Jogeshwari in Salsette (McCann !) ; common throughout Salsette (McCann). *S.M. Country:* Londa (Sedgwick 2538 !). Cultivated in gardens in Gujarat, Bombay and Deccan.

Distribution : Tropical Himalaya, plains from the Punjab to Bengal and down to Ceylon, Assam, Burma, Andamans, Malay Peninsula, Siam, Malaya, New Guinea, Melanesia.

Flowers : May 1917 (Londa) ; 15th June 1930 (Kanari Caves) ; June 1930, July 1928 (Jogeshwari) ; leafed in 1829.

2. **Amorphophallus commutatus,** Engl. in DC. Mon. Phan. ii, (1879) 319 ; Cke. ii, 826. *Conophallus commutatus* Schott in Bonpl. (1859) 28.

Description : Cke. ii, 826. See also Lisboa in this Journal x, (1896) 527.

For biologioal notes see McCann in this Journal xxxiv, (1930) 520.

The following abnormalities were observed by Hallberg in specimens from Mulgaum, Salsette : Leafy carpels, a pedunculate spadix, appendix branched at base and on the same plant a number of cream tubercles amongst the green ovaries. McCann found a specimen with the appendix branched at the tip.

Locality : Konkan : (Stocks, Graham), ; Ambenali (McCann !) Borivli to Kanari Caves (McCann 1244 !, 1641 !, 1642 !) ; hills N.-W. of Bhandup (McCann 707 !, 708 !, 709 !, 710 !, 711 !) ; Bhandup (Blatter 26382 !); in forest near foot of Kanari Caves (McCann 616 !, 617 !) ; foot of hills W. of Mulland (McCann 878 !) ; Vikroli (McCann !) ; S. Konkan (Dalzell and Gibson) ; Bombay (Hallberg !) ; Kurla (Gammie 15118 bis !) ; Marmagao (Woodrow !) ; Bassein (Ryan 1687 !) ; Savantvadi (Dalgado) —*W. Ghats :* From Bombay to Kumpta (Lisboa !) ; Matheran (Cooke !) ; Khandala (McCann !).—*Deccan :* Ganeshkhind Bot. Garden (Paranjpe !) ; Poona (Herb. Calc.).—*S. M. Country :* Astoli (Sedgwick 2615 !) ; Sakharpa, Kolhapur Ratnagiri Road (Bhide !) ; Belgaum (J. H. Burkill).—*N. Kanara :* Karwar (Bell 6140 bis !) ; in forests (Bell 6176 !) ; Bellkerry (Talbot 492 ! in Herb. Sedgwick).

(The last mentioned sheet bears the name *Raphiophallus Hohenackeri* Schott. This is a synonym of *Amorphophallus Hohenackeri* Engl. The specimen however is evidently *A. commutatus.*

Engler mentions the same number by Talbot in the Calcutta Herbarium under *A. Hohenackeri.* It is quite possible that two different species were distributed under the same name).

Distribution : Apparently endemic in the Bombay Pres.

Flowers : April 1901 (Savantvadi) ; May 1908 (Ganeshkhind, Matheran) ; June 1883 (N. Kanara) ; June 1919 (Karwar) ; June 1917 (Bhandup) ; June 1930 (Borivli to Kanari Caves) ; June 1929 (Foot of Kanari Caves) ; July 1928 (Vikroli) ; July 1929 (Bhandup).

Fruit : June 1917 (Bhandup) ; Aug. 1929 (N.-W. of Mulland) ; Sept. 1903 (Bassein) ; Oct. (Ambenali) ; Nov. 1902 (Belgaum).

Uses : The unopened inflorescence is eaten as a vegetable.

3. **Amorphophallus bulbifer,** (Roxb.) Bl. in Rumphia i, (1835) 148 ; Cke. ii, 825. —*Arum bulbiferum* Roxb. Fl. Ind. iii, (1832) 510 ; Bot. Mag, t. 2072, 2508 ; Engl. Pflanzenr. iv, 23 C (1911) 98.—*Pythonium bulbiferum* Schott Melet. (1832) 18.

Description : Tuber about 5·8 cm. diam., subglobose. Petioles up to 1 m. long, 1·5–3 cm. diam., smooth, dirty or olivaceous green, with paler irregular or linear spots ; lamina 3-sect, bulbiferous at the branchings of the ribs and nerves ; primary lateral segments 20–30 cm. long, dichotomous, secondary segments pinnatisect, rarely bipinnatisect, few-jugate, lower segments 4-6 cm. long, 3-4 cm. broad, ovate, upper ones 10-12 cm. long, 6-7 cm. broad, oblong-lanceolate, all long-acuminate. Peduncle 20-30 cm. long, 1–1·5 cm. thick, nearly quite cylindrical all the way up, quite smooth, dark olive green with numerous narrowly oblong, sometimes crowded greyish blotches throughout its length, these blotches having a pinkish shade below in fresh specimens and a greenish shade towards the top of the peduncle, being about 2 cm. in length, sometime coalescent, sometimes, especially upwards, shorter and roundish, all of them with irregular edges. Spathe 10-12 cm. long, 10 cm. broad when expanded, sessile, long-conical before opening, with a small apiculus at top, longitudinally many-veined, the veins towards the margins wider apart and net-veined between, delicate olive green, very light in shade, with many roundish nearly white blotches throughout which are not large, often coalescing and with a pinkish shade towards the base in fresh specimens; inside the spathe is a very delicate shell pink at the base, and in the middle gradually passing into the light olive green of the outside upwards and towards the margins; the veins in the green part always thinly darker. Spadix slightly shorter than the space, about 12 cm. long, shortly stalked, (about 12 mm.), the stalk very delicate dull olive green with somewhat obscure, round, whitish blotches, followed by 5 or 6 rows of female flowers, occupying a space of 1·5–2 by 1·5 cm.; the rows not regular, the lower flowers more developed and more separated from each other than those towards the top which are crowded together forming a mass of stigmata, the former squat pear-shaped, deep red in colour, surmounted by the shortly and thickly stalked stigmata which lean upwards, are circular-convex or nearly disk-shaped, the surface often being uneven; stigma yellow when fresh and still in the spathe, changing to green later on. The male flowers follow immediately after the females without an interval of any kind and are crowded together, occupying a space of 2·5 by 1·5 cm., very delicately shell pink like the inside of the spathe; anthers sessile, generally 5-sided from being so crowded, otherwise globose where free (1 or 2 towards the base), free, with 2 parallel impressed pores on their upper surface. Appendix 5–8 cm. long, 2–2·5 cm. diam., conical, the thickest part about 20 mm. above the base, extreme base about 18 mm. diam., the tip very bluntly rounded, about 8 mm. diam., colour a smooth silky white with a pink tinge, the surface dull but not at all uneven.

For morphological and biological notes see McCann in this Journal xxxiv, (1930) 519.

Localities: Konkan: Ambenali (McCann!); Borivli to Kanari Caves (McCann 1256!, 1252!); hills W. of Mulland (McCann 883!, 884!); hills near Ghorbunder, Salsette (McCann!).—*S. M. Country:* Devarayi (Sedgwick 4124!, 4041!).—*N. Kanara:* Forests (Bell 6108!); Yellapur (Bell 6080!); Pattanpar (Bell!).

Distribution: Chota Nagpur, Bengal, Sikkim, Khasia Hills, Assam, Burma.

Flowers: June 1915 (Pattanpar); June 1918 (S. M. Country); June 1919 (Yellapur).

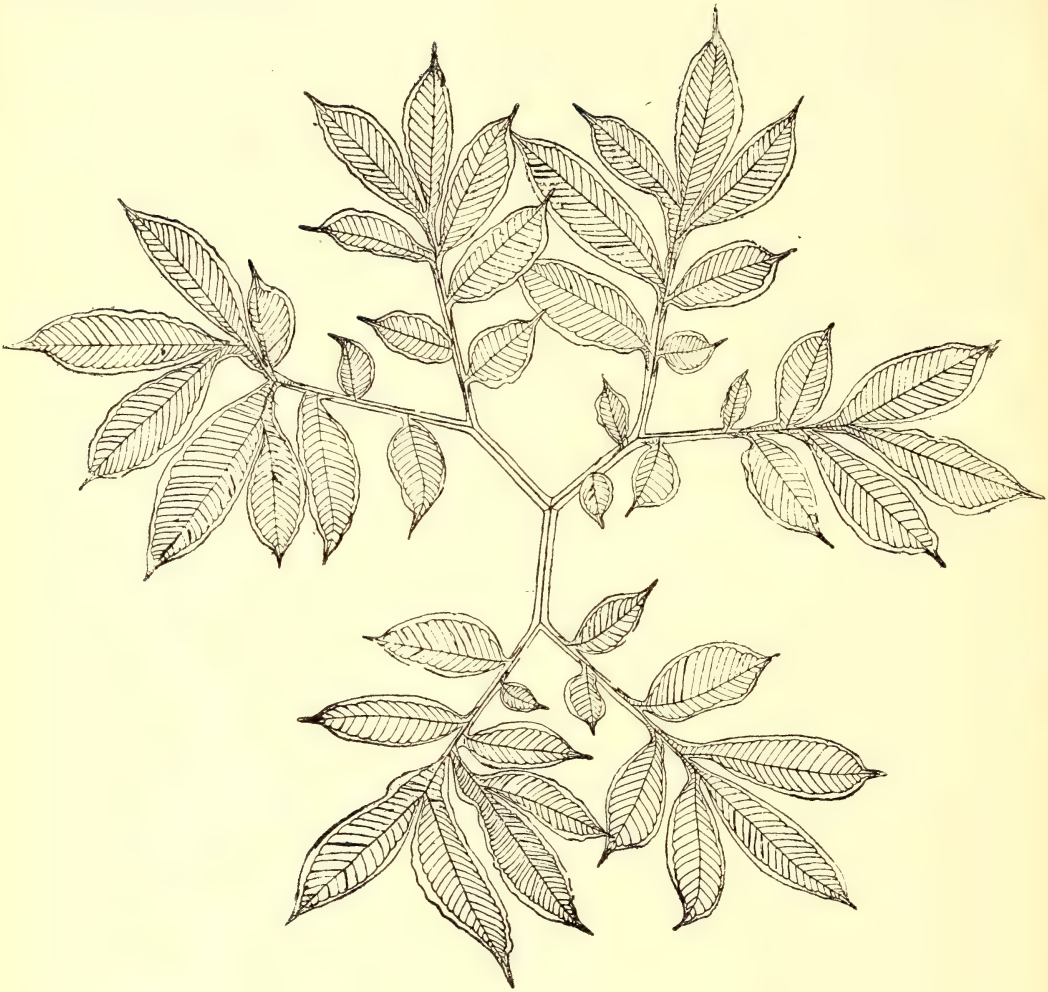
Fruit: 15th Sept. 1929 (Kanari Caves); Oct. 1930 (Ambenali).

4. **Amorphophallus silvaticus,** (Roxb.) Kunth Enum. iii, (1841) 34; Engler Pflanzenr. iv, 23C (1911) 103, fig. 35 A-E. *Arum silvaticum* Roxb. Fl. Ind. iii, (1832) 511; Wight Ic. t. 802. *Synantherias silvatica* Schott Gen. Ar. (1858) t. 28; Hook. f. Bot. Mag. t. 7190 *et* F.B.I. vi, (1893) 518. *Amorphophallus zeylanicus* Bl. in Rumphia i, (1835) 148.—*Brachyspatha zeylanica* Schott Syn. (1856) 36.

Description: Tuber 5–6 cm. diam., slightly depressed. Petioles long, smooth, green; lamina 3-sect, primary lateral segments dichotomous, secondary ones pinnatisect, tertiary ones lanceolate or obovate, acuminate, decurrent with the exception of the lowest. Peduncle about 20-25 cm. long, 1 cm. diam. Spathe about 5 cm. long, 3 cm. broad, erect, ovate, in the middle convolute, inside white, greenish at the apex, outside green, white striate, towards the margin white-spotted. Spadix stipitate, up to 3 times as long as the spathe. Female inflorescence 1·5 cm. long, interval bearing the neuter flowers 1·5 cm. long; male inflorescence 2–2·5 cm. long, 4 mm. diam., appendix 10–15 cm. long, 5 mm. thick below, elongate-conical, flexuose, above the inflorescence slightly thickened, longitudinally sulcate, pale straw-colour. Stamens short or disposed round a naked disk, or irregularly scattered; anthers subsessile, the thin connective slightly raised above the lobes. Neuters uniseriate, oblong, depressed, rugose. Ovary 1·5 mm. long, globose, 2-locular, loculi 1-ovuled, ovule attached to the middle of the dissepiment; style 0·5 mm. long; stigma slightly 3-lobed.

Locality: N. Kanara: Bedoli (Herb. Econ. Bot. Poona 1!).

Cooke (ii, 829) excludes this species, because Engler gives Bombay as locality of a specimen which in reality refers to a plant originating from the Nilgiris and Coorg. In the meantime a specimen has been gathered in N. Kanara,



Del C. McCann.

Leaf of *Amorphophallus commutatus*, Engl.

Distribution : N. Kanara, Nilgiris, Malabar, Circars, Ceylon in dry regions.
Flowers : Sept. 1893.

5. **Amorphophallus Hohenackeri,** (Schott) Engl. and Gehrm. in Engler Pflanzenr. iv, 23C (1911) 103, fig. 35, f-m.—*Raphiophallus Hohenackeri* Schott Gen. Ar. (1858) t. 27.—*Hydrosme Hohenackeri* Engl. in Engl. and Prantl Pflanzenf. ii, 3 (1887) 128 *ibid.* Nachtr. i, (1897) 59.

Description : Tuber 2-3 cm.diam. Petiole 20-30 cm. long, 2 cm. diam., lamina 3-sect; primary segments 10-15 cm. long, dichotomous, secondary segments scarcely 10 cm. long, pinnatisect, tertiary segments 2-6 cm. long, 1·5–3 cm. broad, oblong, acute, cuneately decurrent, lateral nerves numerous, parallel, spreading, united into an intramarginal nerve not far removed from the margin. Peduncle scarcely 30 cm. long, thin. Spathe about 8 cm. long, 3 cm. broad, tube convolute, open above; lamina erect, lanceolate, acute. Spadix short-stipitate, slightly shorter than the spathe, or as long; female inflorescence 1·5 cm. long; neuters gibbous, occupying the 5 mm. long space between the female and male inflorescences; male inflorescence 1 cm. long. Appendix 3·5-4 cm. long, 1 5 mm. thick, elongate, thin, subulate. Anther-lobes obovoid, with 2 confluent pores at the apex forming a transverse small slit. Pistil obpyramidal-tetragonous, 3-locular; stigma sessile, broad, discoid, slightly 3-4-lobed.

Locality : N. Kanara (Talbot 492 ex Engler).
Distribution : Mangalore.
Flowers : June 1883.

9. COLOCASIA Schott.

Tall herbs, tuberous or with a stout short caudex, flowering and leafing together. Leaves with a stout petiole; lamina peltate, ovate-cordate or sagittate-cordate. Spathe with a stout peduncle; tube ovoid or oblong, convolute, accrescent in fruit, finally irregularly lacerate; lamina oblong or narrowly lanceolate, deciduous. Spadix shorter than the spathe, stout or slender; female inflorescence short, male inflorescence long, cylindric, usually interposed neuters between the two. Appendix erect, elongate-conical or fusiform, subulate or abbreviate, mucroniform. Male flowers 3-6-androus. Female flowers 3-4-gynous; ovary ovoid or oblong, 1-locular; ovules several or many, biseriate; style 0 or short in the beginning, later on 0; stigma depressed-capitate, very shortly 3-5-sulcate. Berries obconic or oblong, many-seeded. Seeds oblong, sulcate. Albumen copious; embryo axile.

Species 7.—Tropical Asia.

Only one species grows in the Presidency, known in Indian Floras under the name *Colocasia antiquorum,* which name has to be changed into :

1. **Colocasia esculenta,** (Linn.) Schott Melet. i, (1832) 18; Kunth Enum. iii, (1841) 37.—*Arum esculentum* Linn. Sp. Pl. (1753) 965, ed. 2 (1763) 1369. *Caladium esculentum* Vent. Hort. Cels. (1800) 30—*Colocasia antiquorum* Schott l.c, ; Hook f. F.B.I. vi, (1893), in Bot. Mag. (1894) t. 7364.—For synonyms see Hook. f. l.c.

Description : Stem above ground 0, or slightly swollen at the base of the leaf-sheaths, arising from a hard tapering rhizome or in cultivated forms a tuberous rhizome, suckers and stolons sometimes present. Petiole erect, up to 1·2 m. long; lamina thinly coriaceous, peltate-ovate, cordate at the base, up to 50 cm. long, rarely longer, with a triangular sinus cut $\frac{1}{3}$ to half way to petiole, with a dull, not polished surface above, paler or coloured beneath, but rarely very glaucous. Peduncle much shorter than the petiole; spathe pale yellow, 15-35 cm. long; tube greenish, oblong; lamina narrowly lanceolate, acuminate, convolute, never widely open, curved slightly backwards in flower. Spadix much shorter than the spathe, rather slender. Female inflorescence as long as the sterile male inflorescence. Appendix much shorter than the inflorescence, style very short. Stigma discoid.

Locality : Konkan : Mumbra (Sedgwick 7658 !); Condita (Blatter and McCann 26375 !); Borivli to Kanari Caves (McCann 1250 ! 1251 !); hills W. of Muilund (McCann 880! 881!); hills N.-W. of Bhandup (McCann 702 !).—*Deccan:* Satara (Herb. St. X. C. 26389 !).—*N. Kanara :* Nagayali (Sedgwick 2929 !), Widely spread throughout the heavy rainfall area (Sedgwick).

There is not the slightest doubt, that the plant is growing wild in many parts of the Presidency, especially in N. Kanara Otherwise cultivated.

Distribution : Wild and cultivated throughout the hotter parts of India and Ceylon. Cultivated in all hot countries.

Flowers : July 1917 (Condita) ; Aug. 1929 (Mullund) ; Sept. 1917 (Nagayali, Condita) ; Sept. 1920 (Mumbra).

Fruit : Aug. 1929 (Mullund) ; Sept. 1929 (Borivli to Kanari Caves).

10. ARIOPSIS Nimmo (Cke. ii, 827).

Species 1—India.

1. **Ariopsis peltata** Nimmo in J. Grah. Cat. Bomb. Pl. Addend. (1839) 252 ; Hook. f. in. Bot. Mag. t. 4222 *et* F.B.I. vi, (1893) 519 ; Cke. ii, 827 ; Engl. Pflanzenr. iv, 23E (1920) 130.—*A. protanthera* N. E. Br. in Rep. R. Gard. Kew (1877) 57.—*Remusatia vivipara* Wight Ic. iii, (1847) t. 900.

Description : Cke. ii, 827.

The tubers are subglobose or ovoid, 2-4 cm. diam. The lamina of the leaf up to 25 cm. across.

Vern. name in the Konkan ; Khadaktiri.

Locality : Konkan (Stocks) ; hills N.-W. of Bhandup in forests (McCann 696 !, 701 !, 703 !) ; Borivli to Kanari Caves (McCann 1203 !); Bassein range, Thana Dist. (Ryan !); Roha (Damle 542 !).—*W. Ghats:* Khandala (Hallberg!); Panchgani (Blatter !); Ambe Ghat (Shevade !).—*N. Kanara :* Karwar (Bell 6106 !, 4076 !, Talbot !); Karwar and Belekeri (Talbot 494 !).

Distribution : Subtropical Himalaya from Nepal to Sikkim, Assam, Burma, Konkan, W. Ghats from Bombay to Travancore.

Flowers : May 1917 (N. Kanara) ; June (N. Kanara) ; 7th July (Borivli to Kanari Caves).

Fruit : May 1917 (N. Kanara) ; June (N. Kanara); July 1929 (Borivli to Kanari Caves).

11. REMUSATIA Schott.

Species 2.—Tropical Africa and Indo-Malaya.

1. **Remusatia vivipara** (Lodd.) Schott Melet. i, (1832) 18 ; Gen. (1858) t. 36 ; Cke. ii, 828; Krause in Engl. Pflanzenr. iv,23E(1920) 16, fig. 4,A-M.—*Caladium viviparum* Lodd. Bot. Cab. (1820) t. 281.—*Colocasia vivipara* Thw. Enum. (1864) 336.—*Arum viviparum* Roxb. Hort. Beng. (1814) 65, Fl. Ind. iii, (1832) 496 ; Wight Ic. iii, (1844) t. 798.—Rheede Hort. Mal. xii, (1703) t. 9.

Description : Cke. ii, 828.

Locality : Konkan : Both Konkans (Nimmo) ; clefts of trees in Ghat jungles (Dalzell and Gibson) : Neral (Bhiva !) ; Bassein (Ryan 1544 bis !) Ambenali (McCann !).—*W. Ghats :* Khandala (Hallberg !, Chibber 53 !) ; Duke's Nose near Khandala, on trees (Meebold ex Engler) ; very common at Khandala (McCann) ; Lonavla (Woodrow !) ; Koina Valley below Mahableshwar (Cooke!); Panchgani, cliffs of Tableland (McCann 2867 !, Blatter !).—*S. M. Country :* Astoli, on trees and evergreen (Sedgwick 2649 !).—*N. Kanara :* Sulgeri (Bell 4279) ; Goona (Talbot !), Yellapur (Talbot !).

Distribution : Subtropical Himalaya from Kumaon to Sikkim, Khasia Hills, Burma, Chota Nagpur Konkan, W. Ghats, N. Kanara, Mysore, Ceylon, Cochin-China, Java, tropical Africa.

Flowers : Feb. 1890 (N. Kanara).

Fruit : July 1917 (S. M. Country).

12. RHAPHIDOPHORA Hassk. (not in Cke.).

Creeping or scandent, rooting on trees. Leaves distichous. Petiole geniculate, more or less vaginate. Lamina lanceolate or oblong, more or less oblique, entire or pinnatipartite or pinnatisect, often very large ; primary nerves many, secondary branching. Spathe ovate, acuminate, deciduous. Spadix stipitate, dense-flowered, shorter than the spathe. Flowers hermaphrodite or few female. Perianth 0. Stamens 4 ; filaments linear, suddenly narrowed into a thin acuminate connective; anthers terminal. Ovary long, subtetragonous- (or hexagonous-) prismatic, truncate, sub-bilocular, cells several-ovuled, ovules many, parietal. Style almost absent or elongate-conical ;

stigma elliptic or oblong. Berries confluent and their tissue loaded with intercellular needles. Seeds oblong, attached to a long funicle. Albumen copious. Embryo axile, erect.

Species 60.--Indo-Malayan.

1. **Rhaphidophora pertusa** (Roxb.) Schott in Bonpl. v, (1857) 45; Hook. f. F.B.I. vi, (1893) 546; Engler Pflanzenr. iv, 23B (1908) 47.--*Pothos pertusus* Roxb. Fl. Ind. i, (1832) 455; Wight Ic. t. 781.--*Scindapsus pertusus* Schott Melet. i, (1832) 21.--*Raphidophora lacera* Hassk. Kat. Bog. (1844) 58; Pl. Jav. Rar. (1848) 155.--*Scindapsus peepla* Thw. Enum. (1864) 336.—Rheede Hort. Mal. xii, t. 20, 21.

Description: A tall climber; stem stout, 2·5-3·5 cm. diam.; internodes 5-8 cm. long. Petiole deeply channelled above, 15-30 cm. long, when young with a membranous sheath 12-14 mm. wide below, narrower upwards; lamina herbaceous, broadly ovate in outline, shortly cuspidate at the apex, at the base slightly cordate or subtruncate, unequal-sided, 20-45 cm. long, 15-30 cm. broad, on the narrower side entire or pertuse, holes mostly oblong, the other side pinnatifid; segments 3-4, of equal length, inequilateral, broadened towards the apex, truncate, upper margin obliquely and upwards falcate-acuminate, confluent below; adult lamina pinnatipartite, on each side 5-11 linear, obliquely falcate-acuminate segments. Peduncle short, terete, 5-8 cm. long. Spathe fleshy, yellow, ovate-oblong, 10 and more cm. long including the acumen which is 2 cm. long. Spadix sessile, cylindrical, 8-9·5 cm. long and about 1·5 cm. diam. Pistils prismatic, 5-6 mm. long; style tetragonous, very short; stigma subsessile.

Locality: N. Kanara: Goodehalli, in evergreen (Sedgwick 6810!).

Distribution: N. Kanara, Nilgiris, Coromandel, Ceylon, Java.

13. Pothos Linn. (Cke. ii, 828).

Species about 60.—Indo-Malayan, Madagascar.

1. **Pothos scandens** Linn. Sp. Pl. (1753) 968; Bot. Reg. t. 133; Hook. Ic. Pl. ii, t. 175. Cke. ii, 828 (*partim*); Engler Pflanzenr. iv, 23B (1905) 26.—*P. exiguiflorus* Schott Aroid. i, (1853) 21, t. 41.—*P. fallax* Schott Prodr. (1860) 560.—*P. decipiens* Schott in Bonpl. (1859) 165.

We have followed Engler in separating *P. scandens* Roxb. and *P. Roxburghii* De Vriese from *P. scandens* as conceived by Hook. f. in F.B.I. vi, 551 and Cooke Fl. Bomb. ii, 828. The description, therefore has to be changed.

Description: Internodes of branchlets 1·5-2 cm. long. Petiole more or less cuneate, 4-5 cm. long, more than 7-9 mm. broad, with rotundate auricles, more or less shorter than the lamina; lamina lanceolate obtuse at the base, gradually narrowed towards the apex, acute, 6-8 cm. long, 1·5-2 cm. broad. Peduncles short, together with the spadix scarcely reaching ¼ of the petiole, 1·5-2·5 cm. long; upper cataphylls ovate, acute, about 0·5 cm. long. Spathe ovate or ovate-oblong, apiculate, 7-8 mm. long. Spadix slightly longer than the stipes, 6-7 mm. long about 4 mm. diam. Berries oblong-ovoid, almost 1 cm. long, 5-6 mm. diam.

Locality: Konkan: (Stocks); in dense jungles (Graham); jungles of Goa (Lush); Marmagao (Bhiva!).—*W. Ghats:* Ghat jungles (Dalzell a Gibson); Amboli (Gammie 15022!).—*N. Kanara:* (Chibber!); Devimani Ghat (Kulkarni!); Castle Rock (Gammie 15552! Bhide!); Yellapur (Talbot 4433!); Sumpkhund (Talbot 3692!); Kadgal (Woodrow); Anmod (Sedgwick 3217!); Guddehalli, Karwar (Sedgwick 6785).—Very common in N. Kanara (McCann).

Distribution: Konkan, W. Ghats to Travancore and Ceylon, Sylhet, Assam, Khasia Hills, Chittagong, Andamans, Nicobars, Malay Peninsula, Siam, Cochin-China, Tonkin, Malay Archipelago to the Philippines.

Flowers: Feb. 1905 (N. Kanara); June 1902 (Castle Rock).

Fruit: May (N. Kanara); Nov. 1908 and 1910 (N. Kanara).

(*To be continued*)

THE BIRDS OF THE PROME DISTRICT OF LOWER BURMA.

BY

J. K. STANFORD, M.C., I.C.S.

WITH NOTES ON THE COLLECTION

BY

DR. CLAUD B. TICEHURST, M.D., M.A., M.B.O.U., F.R.G.S.

PART III.

(*Continued from page 915 of Vol. XXXIV*).

Burmese Small Yellow-naped Woodpecker (Picus chlorolophus chlorophoides). ♂♀ 341, 365.

I saw several, nearly all in pairs, between 1,800 ft. and 2,400 ft. near Nyaunggyo in bamboo jungle, which were exceedingly tame. The nuchal crest was frequently raised and very noticeable. I did not see it elsewhere. Oates found it on the Thayetmyo-Toungoo border and not elsewhere in the Pegu Division.

Spotted-breasted Pied Woodpecker (Dryobates analis). ♀ ♂ 114, 307.

Oates described it as rather common near Thayetmyo. I only saw two single birds one near Tarokmaw on 3rd February and one in bamboo jungle on 28th March near Prome.

[I do not feel quite satisfied that the race *longipennis* is recognizable. All that can be said is that some Burmese specimens attain a greater wing length than Javan examples ; the pectoral spotting is variable in character.]

Northern Yellow-fronted Pied Woodpecker (Dryobates mahrattensis aurocristatus). ♂♀ 136, 324.

Oates describes it as confined to Northern Pegu but abundant at Thayetmyo ' for some distance down the river.' I shot a single female near Hmawza on 30th March, 1929, in *indaing* jungle which uttered a shrill note quite unlike a woodpecker's. Another was obtained out of a small party near Tonbo on 7th February.

[These belong to the northern race with rather a longer wing and more white on the upper parts than the South Indian bird. I do not consider them to be different from Bengal birds and so they must be called *aurocristatus* instead of *blanfordi*. I see no generic difference between *Dryobates* and *Leiopicus*.]

Burmese Pigmy Woodpecker (Dryobates h. canicapillus). ♂ 152.

Oates got it in Pegu and recorded it from Arakan. I shot one out of a pair in the Tonye Reserve on 11th February, the only ones seen.

Tickell's Golden-backed Woodpecker (Chrysocolaptes guttacristatus guttacristatus). ♂ 268.

I obtained this bird near Prome where it was about the commonest woodpecker. Presumably Stuart Baker's reference to Hopwood taking eggs of *delesserti* in Tharrawaddy in May should refer to this bird.

Northern Rufous Woodpecker (Micropternus brachyura burmanicus). ♀ 23.

One was obtained on 18th January, 1929, near Paukkaung. I saw one or two at other times, but it was nowhere common.

[This is a very difficult group of woodpeckers and I think possibly too many races have been recognized. In the *Fauna*, Arakan is given as the type locality of *phaioceps*, but this is not correct as the type comes from the vicinity of Calcutta. That being so, I should have hardly thought that another race *mesos* would be found at Kuttak in Orissa. The single bird obtained, has a wing of 135 mm.].

Black and Buff Woodpecker (Miglyptes jugularis).

It is probably confined to the hills. Oates obtained it on the Arakan side and says it occurs in evergreen forest on the Pegu side. I saw some small woodpeckers in bamboo jungle near Nyaunggyo which I failed to obtain.

Burmese Heart-spotted Woodpecker (Hemicircus canente canente).

Oates (ii ; 30) got one near Nyaunggyo. I am fairly certain I saw it there, but failed to obtain any.

Indian Great Slaty Woodpecker (Mullerlpicus pulverulentus harterti).

Oates obtained it in dense forest on the Arakan Hills.

Burmese Great Black Woodpecker (Thriponax javanensis feddeni).

Oates found it ' abundant ' at Thayetmyo and east to the Pegu hills, and says he had several specimens from the Arakan Hills. It is not common but I have seen single birds in forest-reserves in the Arakan foot hills, and also one in the Nawin reserves east of Paukkaung in February 1928.

Wryneck (Iynx torquilla japonica) ?

Oates observed it yearly as a winter visitor near Thayetmyo. All those I saw were between October and April and all single birds. The latest seen by me was one west of the Irrawaddy near Padaung on 15th April, 1929 ; I also saw a single bird on the Inma lake on 24th December, 1928.

Burmese Lineated Barbet (Thereiceryx lineatus hodgsoni).

Henricks shot one near Theme on 24th February, 1929. It is doubtless common as described by Oates, but I collected very few barbets. It is certainly very common further south in the *Yomas* of the Insein district.

[*T. l. intermedius* seems to be separated as a recognizable race on a wing length averaging a few millimetres less than *hodgsoni*. A series of *hodgsoni* from Nepal, Bhutan and Buxa measure 119–139 mm. and a series from Southern Shan States and Tenasserim 120–135 mm. I am therefore unable to recognize *intermedius* as distinct. If the birds from further south in the Peninsular of Burma and Siam are really distinct, they will require another name. This Prome bird has a wing of 132 mm.]

Blue-throated Barbet (Cyanops asiatica asiatica).

Oates only found it in evergreen forest on the east side of the Pegu Hills. The only barbets obtained by me in the Arakan Hills (where, judging by their notes, they were exceedingly common) were of this species. In fact the feature of the table-land on the ridge near Nyaunggyo in April is the enormous number of barbets which can be heard calling in every direction throughout the day.

Burmese Crimson-breasted Barbet (Xantholæma hæmacephala indica). ♂ 245, 62. L
Very common in the plains.

Cuckoo (Cuculus canorus sub sp.?).

I have never seen it for certain, but Oates (ii. 103) obtained one at Prome in November.

Burmese Plaintive Cuckoo (Cacomantis merulinus querulus). 102, 304.

Nearly all I saw were on or around the edges of the big jheels near Shwedaung. Oates notes its partiality for grassy plains and swamps.

Indian Banded Bay Cuckoo (Cacomantis sonneratii sonneratii). ♀ 20. 270.

One was obtained near Paukkaung on 18th January 1929, and I shot another on 12th March, out of some bushes on the Nawin stream near Prome. Wardlaw Ramsay got it at Thayetmyo, but it was apparently never seen by Oates.

[The very slight distinctions between *Cacomantis* and *Penthoceryx* do not appear to me to be of a generic character.]

Red-winged Crested Cuckoo (Clamator coromandus).

I saw a single specimen on 10th April, 1929, in long grass near the Taungup Pass. It was probably overlooked by me otherwise, though I have frequently seen it in the Insein district.

Malay Koel (Eudynamis scolopaceus malayana). ♀ ♀ ♂ 190, 234, 417.

Very common. The bird most frequently cuckolded is probably *Corvus insolens*.

[I agree with Mr. Baker that the Burmese birds cannot, by their larger bill and more rufous underparts in the female, be united with the Indian Koel *scolopaceus*.]

Large Malay Green-billed Malkoha (Rhopodytes tristis longicaudatus). 182, 183, 184, 275.

Very common near Prome and probably throughout the whole district.

Common Crow-Pheasant (Centropus sinensis intermedius). 249. Local name : *Bok*.

Very common. Nearly always found close to water.

Lesser Coucal (Centropus. b. bengalensis). 214.

Oates described it as 'local'. I failed to observe it at all, but Henricks got male at Ngaphaw on 25th February.

Large Burmese Paroquet (Psittacula eupatria indoburmanica). 413, 414.

I should say this paroquet was common, but I had little opportunity of collecting them. Those shot were in a family party feeding on stubble near Prome on 17th April.

Almost every evening at Prome flocks of paroquets, at an immense height, used to cross the Irrawaddy from west to east. From the pace and height at which they were travelling, they appeared to be coming from the Arakan Hills, which at this point, were only about fifteen miles away. On several occasions I found very large numbers of paroquets coming in to roost in the dense toddy-palm groves along the railway line near Hmawza. I did not see this bird in the Arakan Hills in April.

Eastern Rose-ringed Paroquet (Psittacula krameri borealis). 267, 278, 309, 415.

Very common and probably the most abundant of the family. It roosts in large toddy-palms, and breeds there in January and February. I have also seen flocks roosting in mango trees.

[Besides the red bill in both sexes these birds are duller in colour on the upper and under parts than the Indian race.]

Burmese Slaty-headed Paroquet (Psittacula schisticeps finschi). 318.

Oates apparently found it on the Pegu Hills. I shot one in scrub near Prome on 30th March out of a pair, and saw others in April, and a few near Nyaunggyo on the Arakan side. I should say it was not common.

Indian Loriquet (Corryllis vernalis vernalis). 337.

This bird must be very local, as I do not think I can have overlooked it for two years. The only ones seen were a party of 4 or 5 on 3rd April, 1929, which sat clustered, as if stupefied, on a small tree above Nyaunggyo, and did not move even when I shot one. I saw a single bird near the same place a few days later.

Burmese Roller (Coracias benghalensis affinis). 71, 178, 285.

Very common all over the district, except that, on the Arakan side in April, it was not found above 1,000 feet.

Broad-billed Roller (Eurystomus o. orientalis).

Oates describes it as comparatively rare and local. I shot one out of a party of five or six at Nyaunggyo on 15th April, 1928, and though looking for it carefully during the following year, failed to observe any. These birds were hawking from the top of an immense dead forest-tree, flying round at a considerable height, but coming occasionally within gun-shot of the ground. They were noticeably more alert and hawk-like than *Coracias affinis*.

Burmese Green Bee-Eater (Merops orientalis burmanus). 282.

Extremely common over the whole district, except in the hills, and apparently resident, as I have seen it throughout the year, the other bee-eaters being certainly migratory. It is paired in its breeding haunts by mid-January. I found a clutch of two fresh eggs on 23rd March, 1928, and caught the hen bird in the hole at dusk. In another nest I found naked young at the mouth of the nesting-hole on 16th April, 1928. From observations in the Insein District during August 1928, I am certain this species is migratory there.

Blue-tailed Bee-Eater (Merops superciliosus javanicus).

Oates considered this bird to be resident in Pegu. In Prome it is most decidedly a migrant, arriving to breed in mid-March and departing again probably in September or October. I could not get a specimen at all during January or February 1929 though constantly on the look out for it, and saw none up to 20th March. It breeds in considerable numbers in the banks of all the larger streams, and is never seen far from water. The evening flight of this species just before dusk when they are gathering to roost is a very memorable sight. On 4th and 11th April, 1929, I saw pairs and single birds at 3,000 feet in the Arakan *Yomas* which were apparently passing migrants. These were the only ones seen in these hills. This bird nests in April. I have seen it up to late November in the Insein district, but it seems to disappear in the cold weather.

Chestnut-headed Bee-Eater (Melittophagus e. erythrocephalus). 209, 210.

Oates described it as found ' sparingly ' in forests and well-wooded parts in small flocks and breeding in colonies. The only place where I found this bee-eater was at Ngaphaw in the foot-hills of the Pegu Yoma, where I found several pairs breeding within a few hundred yards of each other along the Ngaphaw stream on 25th February, 1929. I watched at least two pairs excavating nest-holes which were not in sheer banks but in loose sand. Both birds sat close together and assisted in the digging. It may be worth while recording that in the Sunderbuns of the Khulna District (Bengal), Mr. L. R. Fawcus and myself in April 1922 found a considerable number of these birds breeding in little holes like mouse-holes on the flat sand-dunes near the sea. Appears to be resident in the Insein district.

[I see no difference between these and specimens from Ceylon, the type locality.]

Blue-bearded Bee-Eater (Bucia athertoni). 399.

In Prome District it is probably confined to the summit of the *Yomas* on both sides. Oates got it near Nyaunggyo where I saw ten or twelve between 2,400 and 3,000 feet in April 1929. They were exceedingly shy and kept to very tall tree-jungle, with the exception of the bird I obtained which was seen two or three times near the same place, and probably had a nest in the bank of the Taungup road. The one I saw at a little distance, appeared to be eating berries in a tree-top. They very rarely returned to the same spot when disturbed, as other bee-eaters do.

Indian Pied King Fisher (Ceryle rudis leucomelanura).

Common on the jheels along the Irrawaddy valley. I did not notice it elsewhere. Very tame and prone to hovering unlike other king fishers. I saw what appeared to be recently-fledged young in January 1929.

Common Indian Kingfisher (Alcedo atthis bengalensis). 144.

Common all over the district and apparently resident.

Blyth's Kingfisher. (Alcedo megala). 412.

Not recorded by Oates. I shot a female on the upper waters of the Nyaunggyo stream on 14th April, 1929, in dense evergreen forest. I am fairly certain it must have been breeding and I saw possible holes in the stream bank near by, but had no time to investigate. This bird does not appear to have been found previously south of the Chin Hills.

Indian Three-toed Kingfisher (Ceyx t. tridactylus). 371.

Oates found this bird in evergreen forest on the Pegu Hills. On the Arakan side Mr. Potter shot a male on the headwaters of the Mathon stream, west of

Nyaunggyo on 6th April at about 1,000 feet and we subsequently observed one on a small stream near Nyaunggyo in dense bamboo jungle on 9th April. It is probably easily overlooked.

Burmese Stork-billed Kingfisher (Ramphalcyon capensis burmanica). 14.

Quite common and widely distributed. I did not see it in the Arakan Hills.

Indian White-breasted Kingfisher (Halcyon smyrnensis fusca). 86.

Abundant everywhere. It feeds largely on insects. I watched a pair on 13th April, 1928, starting to excavate a hole in the Buyo stream. It is much more a bird of the open country than any other.

Black-capped Kingfisher (Halcyon pileata).

Oates got it just outside the northern boundary of the Prome district at Pyalo on the Irrawaddy. I have never seen it.

Indian Ruddy Kingfisher (Entomothera coromanda coromanda).

A kingfisher of this species flew into my dining-room at Prome on 17th April, 1929, and collided with the *punkah*, whilst three of us were at breakfast. It then flew out of the window into a tree near by and gave me a brief but quite clear view; it was unfortunately disturbed before I could secure it. Oates obtained this species near Pegu.

Great Pied Hornbill (Dichoceros bicornis).

I found it common between 2,000 ft. or 3,000 ft. in the Arakan Hills in April and saw large gatherings, apparently of males, assembled on fruit trees on more than one occasion, but failed to secure any.

Burmese Pied Hornbill (Anthracoceros malabaricus leucogaster). 229, 230.

This appears to be the common Hornbill of the district. Oates found it breeding in March. I shot a male on 28th February at Ngapaw with very enlarged *testes*. This pair used to fly every morning across a wide valley at dawn to feed on a *nyaung*-tree. The female would probably have laid within a week, judging by her ovary.

[No specimens received.]

Malayan Wreathed Hornbill (Ryhticeros undulatus).

This was found by Theobald (Oates. ii. 93.) in Sandoway and probably occurs in the hills.

Burmese Hoopoe (Upupa epops longirostris). 5.

This bird is common from October to February all over the plains. I found it breeding in the Arakan Hills from 2,000 ft. upwards and cannot recollect seeing any in the plains in 1929 after mid-March. The only nest seen by me was in a hole in a tall tree high up, which one bird constantly visited. While collecting food for their young or sitting mates in these holes, individual birds were exceedingly tame.

Tibetan Hoopoe (Upupa epops saturata). 3.

One out of a pair obtained near Prome on 13th March was of this race.

Red-headed Trogon (Pyrotrogon e. erythrocephalus). 372.

Common between 2,000 ft. and 3,000 ft. on the Arakan side. I observed trogons at about 200–300 ft. in the foot-hills on the Pegu side, but obtained none. *P. oreskios* according to Oates occurs in Arakan and the 'Pegu hills near the frontier' but I did not see it.

Large White-Rumped Swift (Micropus pacificus cooki). 339.

Oates describes them as seen throughout the greater part of the year but usually flying far out of gun-shot in large flocks. In April 1929 this swift was exceedingly common round Nyaunggyo. I only managed to shoot one, but a large flock daily about 9 a.m. used to hawk close over the roof of the bungalow and I saw them also daily on the Taungup road. As it breeds in the Gokteik gorge, it may be found breeding in the Arakan Hills.

Malay House-Swift (Micropus affinis subfurcatus).

Oates never found it for certain. I think this is the species which breeds freely in the High Court at Rangoon. I never saw it in Prome.

Eastern Palm-Swift (Tachornis batassiensis infumatus). 65.

Breeds in toddy-palms. Common and probably resident.

Indian Crested Swift (Hemiprocne coronatus).

Not uncommon in the drier and more open forest. I failed to obtain any.

Burmese Long-tailed Nightjar (Caprimulgus macrourus ambigus). 410.

This was the only nightjar obtained by me in the Arakan Hills. I failed to find it nesting. Its note I have heard also on the east side of the Irrawaddy. It is the syllable 'tuk, tuk, tuk,' repeated three or four times. I repeatedly saw this bird hovering at night.

[This nightjar is quite distinct from the next one. It matches in colour fairly well birds from Singapore (*bimaculatus*) but is too large for that race. ♂ wing 207 mm. Kloss gives the wing measurement of *bimaculatus* as 185–196 mm.]

Nepal Long-tailed Nightjar (Caprimulgus macrurus nipalensis). 225.

One shot by me on 27th February at Ngaphaw (200 ft.) was referable to this species. It was in stubble near the Ngaphaw stream.

Common Indian Nightjar (Caprimulgus asiaticus). 216.

Common and widely distributed. I did not find it breeding. Oates does not record *C. monticolus* from anywhere in the Pegu Division except Toungoo. The only one shot was near Ngaphaw on 26th February. The call of the commonest nightjar heard at night east of the Irrawaddy was the (four-syllabled) 'tuk, tuk, te tuk,' unlike that of *macrurus*.

Burmese Great-eared Nightjar (Lyncornis c. cerviniceps).

Oates describes it as 'very abundant at the foot of the Arakan Hills near Prome', and found it common on the Thayetmyo-Toungoo *Yoma*. I saw none but have found it since in the Insein district further south. Stuart Baker's description of its breeding near 'Myingyan on the Upper Chindwin' must be a mistake. The area described probably lies in the Upper Chindwin or Monywa districts.

Indian Barn Owl (Tyto alba javanica).

I have seen this owl occasionally but never obtained it. Oates describes it as 'abundant over the whole of Pegu'.

Short-eared Owl (Asio f. flammeus).

Oates had only one record at Toungoo. I saw a single bird in long grass on the Nawin marshes near Prome on 2nd December, 1928. I know this bird well and there cannot have been any mistake as it was close to me. In November 1924, it may be worth recording, I flushed a number of Short-eared Owls in elephant grass near Tamanthi on the Upper Chindwin.

Burmese Spotted Owlet (Athene brama pulchra). Local name :—*Zigwet.*

Oates remarks its abundance in Prome within 15 miles of the Irrawaddy. It is extremely common and far from shy even in daylight and found over most of the district. I watched a pair copulating in December 1927 and again on 1st May, 1928, on a branch immediately after leaving their hollow tree at dusk, a process accompanied by a duet of shrill chattering notes. I have frequently seen these owls hawking flying ants. This owl is one of those which, like the long-eared owl and others, conducts a duet at night in the breeding season.

Jungle Owlet (Glaucidium cuculoides). Burmese :—*Zigwet.* 21, 82.

I saw what I think was a specimen of this owl near Paukkaung in January, 1929, and one was brought to me from the same place on 18th January, 1929. I shot another at Kandin on 24th January This bird has a short single note.

[These owls are very puzzling. The race in Assam to Pegu is said to be *rufescens*, a richly coloured bird of a general rufous brown tint. From a series of such birds, these two birds from the Prome district stand out at once and are as pale and grey above as *cuculoides* from N. W. Himalayas but are rather more rufous on the under-parts than most. Wing ♂ 146 mm.; ♀ 148 mm. I must leave them as indeterminable till further specimens are to hand.]

Osprey (Pandion haliaëtus haliaëtus).

I saw one several times in February 1929 on the Letpanbu jheel and on the last occasion it had become entangled with one of the many fishhooks which Burmans attach to lines fastened to rods in the shallower parts of the jheel. I should not be surprised if it bred along the Irrawaddy valley in this area.

Black Vulture (Sarcogyps calvus).

Not uncommon; I have not been certain of its breeding but I think that odd pairs do so in the large *letpanbin* trees on the islands of the Irrawaddy.

Indian White-backed Vulture (Pseudogyps bengalensis).

Abundant. I did not collect any vultures and failed to identify *Gyps indicus*. *Pseudogyps* nests in some numbers in the cotton trees of the lower Irrawaddy valley, the nests being largely made of leaves.

Eastern Peregrine Falcon (Falco peregrinus calidus).

Oates records obtaining it 'pretty often at Prome'. I failed to observe it.

Burmese Red-legged Falconet (Microhierax cœrulescens burmanicus).

This bird is probably easily overlooked and I only procured one in two years, at about 1,000 ft. in the Arakan *Yoma* foot-hills in April 1928.

Fielden's Hawk (Neohierax insignis insignis).

Oates describes it as 'abundant at Thayetmyo extending to the crest of the Arakan Hills.' The only one I saw was a female on 11th March, 1929, about 20 miles east of Prome on the Paukkaung road. This bird had a soft-shelled egg in the oviduct and another in the ovary as big as a marble. Its flight was curiously weak and much more resembled that of a young parrot than a falcon. The gizzard contained a snake. I am very doubtful if this bird is common in the Prome District, but I may have overlooked it.

Burmese Kestrel (Cerchneis tinnunculus saturatus). ♀ 103.

Fairly common. I saw no signs of it breeding and it was mainly observed from November to March. Oates considered it a winter visitor only.

Large Grey-headed Fishing Eagle (Ichthyophaga i. ichthyaëtus).

I saw a bird two years running sitting on a nest in a large *letpanbin* (cotton) tree at Gwema, in early February. As soon as she left the nest, House Crows made repeated attempts to get at the eggs. As described in the *Fauna*, ed. ii, the nest was in a huge tree close to the bank of the Irrawaddy.

Chestnut Buzzard-Eagle (Butastur liventer). ♀ 205.

Not uncommon. A female shot near Theme on 24th February, had an egg in the ovary a little larger than a pea. I saw two pairs on 7th February near Tonbo. A pair were seen constantly in open jungle near Prome from February to April which were undoubtedly nesting, but they were extremely wary and I failed to locate the nest. Oates twice found eggs in March.

Serpent Eagle (Spilornis cheela burmanicus). ♂ 129.

I shot a solitary male on 6th February near Nyaunggyo with much enlarged *testes*. Otherwise I saw no signs of this bird breeding unless some of the birds seen in the Arakan Hills were wrongly mistaken for *Pernis ptilorhynchus*. [wing 451 mm.]

Brahminy Kite (Haliastur indus indus).

Common. About March this bird, like *Milvus govinda*, almost entirely disappears and is only seen in very small numbers if at all, until September.

Common Pariah Kite (Milvus migrans govinda).

Very common but seems to disappear almost completely by March. Oates (ii 203) says 'from June to September.' Nests in January. In October large gatherings once again become noticeable.

Large Indian Kite (Milvus migrans lineatus). ♂ 300.

I obtained one or two but should not describe it as common and I saw no signs of its nesting. Oates apparently only observed it from October to February and did not find it breeding (ii. 204).

Black-shouldered Kite (Elanus cœruleus).

I did not obtain this bird but saw several. Oates (ii. 205) only observed them in the rains from June to mid-October, but my experience was exactly the reverse. In 1928-29 I saw one on 9th October, a pair on the Letpanbu jheel on 1st February, and a single bird on 20th March, 1929, all others being invariably seen in the 'open season.' Its habit of hovering and its pale grey colour distinguish it at once in the field.

Marsh-Harrier (Circus æruginosus). 89, 99, 269.

Only three were obtained. In the mature plumage (89 and 269), these birds were exceedingly common. I shot one out of a pair on 1st February, both of which had conspicuous pale heads, the only ones seen in this plumage. These birds were frequently seen a considerable distance from water, hunting the low scrub-hills near the Irrawaddy.

[An adult male on 27th January had just completed the moult of the wings ; a female on 1st February is moulting the old whitish feathers of the crown and the new ones in quill are rufous with fine dark central streaks.]

Pied Harrier (Circus melanoleuca melanoleuca). ♂ ♂ ♀ ♀ 32, 34, 246, 269.

Common from November to March. In the immature plumage (34 and 269) it never seems to associate with adult males which I noticed were nearly always seen in ones and twos. It is spread over the whole district at this time of the year, and is the commonest of the Harriers.

Shikra (Astur badius poliopsis). ♂ ♂ ♀ 90, 189, 231.

I shot three ; one was a male of a pair which were in my garden on 30th January ; the second was a single male in a tree in *indaing* jungle near Prome and the last was a solitary female near Ngaphaw which was hawking insects over a jungle fire in company with kites, swallows and cuckoo-shrikes. The stomach contained two small lizards and a bundle which looked like the remains of a spider.

[These birds are a trifle larger than *dussumieri*, the proportions of wing to tail are the same as in this race (cf. *Fauna*, ed. ii.]

Crested Honey-Buzzard (Pernis p. ptilorhynchus ?). ♂ 391.

The only one obtained was shot at 3,000 ft. near Nyaunggyo in April. A buzzard which, I think, belonged to this species, was common here and undoubtedly breeding, and I saw it also up the Mathon stream in April 1928, It has a loud-ringing note of four syllables which can be heard a mile or more away, and has a curious 'display' flight in which the wings are moved rapidly in short strokes. Oates mentions (ii, 203) that he obtained it at Prome and Thayetmyo and apparently found it breeding.

[Longest crest feathers 32 mm. ; wg. 431 mm. The crest is fairly well developed and the wing is large for the Indian race *ruficollis.* Forehead and lores ashy grey ; under-parts white, barred on the flanks and streaked on the breast with fulvous.]

Siberian Honey-Buzzard (Pernis apivorus orientalis) ? ♂ 24.

One was obtained near Paukkaung by Mr. Williams on 18th January, 1929, and I saw several about this time near the same place. Those I saw were in pairs. They struck me as being very sluggish birds. Oates did not meet them.

[The wing 400 mm. appears to be very small for *orientalis.* A very white bird on the under-parts with heavy median brown streaks on the breast.]

Burmese Black-crested Baza (Baza leuphotes burmana).

Oates apparently never met it. I had a close view of one of a pair in high tree-jungle at the Nyaunggyo stream sources on 14th April, 1929. From the white breast and the fact that I noted both birds at the time to be 'as black as crows', there is, I think, no doubt of the species. The crest of the bird I saw was raised perpendicularly. The note was a whistle like a kite's and I have little doubt they were breeding.

Burmese Green Pigeon (Crocopus phœnicopterus viridifrons). ♀ 312.

Oates (BB ii. 307) says that it is ' spread over the whole province alike in the hills and plains ', whereas in *Stray Feathers* (vol. iii), he says, ' I have never received it from the Pegu Hills nor from those of Arakan. It is essentially a bird of the plains.'

I did not see any in the Arakan Hills in April 1929. I have seen flocks near Paukkaung as late as mid-May, and others at the foot of the Arakan Hills in mid-April.

[This appears to be *viridifrons* though the wing (sex ♀) is 176 mm. ; Mr. Baker gives the range as 184-200 mm.]

Ashy-headed Green Pigeon (Dendrophasa pompadoura phayrei). ♂ 353.

Oates says it is confined to the denser forests on the hills. I saw a fair number at 3,000 ft. above Nyaunggyo in April 1929 in the company of Pin-tailed Green Pigeons, where they were exceedingly tame and pairing.

Pin-tailed Green Pigeon (Sphenocercus a. apicauda). ♂ 338.

Oates did not meet with this bird at all in Pegu. I found it quite common from 2,400 ft. to 3,000 ft. near Nyaunggyo in April 1929, many being paired and others pairing. They were exceedingly tame and I frequently flushed pairs from the grass on the Padaung-Taungup road, and watched others feeding at very close quarters. They are very parrot-like when in trees. Probably in the Pegu Division it is entirely a bird of the hills.

[This Pigeon has a broad, black band across the central tail, a character omitted in the *Fauna*. *Apicauda* is surely substantive and cannot be altered to *apicaudus* !]

Wedge-tailed Green Pigeon (Sphenocercus s. sphenurus). ♀ 333.

Oates says : ' Found throughout the hill portions of Pegu.' I got one, more or less by accident, on 2nd April, 1929, at Nyaunggyo. It was with a flock but I thought the latter were mainly *apicauda*.

Green Imperial Pigeon (Muscadivora ænea sylvatica).

Very common in the cold weather, especially just across the Irrawaddy, near Prome. I have not seen any after February and saw none in the Arakan Hills in April.

Indian Emerald Dove (Chalcophaps indica indica). ♀ 226.

Common in the denser portions of the district and occurs up to 3,000 ft. on Arakan side, where I found a nest with young a few days old in bamboo on 11th April, 1929. The bird was extremely wary and difficult to observe entering and leaving the nest.

Blue Rock-Pigeon (Columba livia). ♂ 181.

Oates never met it though in the *Fauna* (v. 221), Macdonald is quoted as saying that it is ' common in Myingyan.' Large numbers exist in a semi-domestic state round most *pongyi-kyaungs*. The bird shot by me was drinking at a pool of salt gaseous water.

On two occasions in April 1929, I saw a very large Pigeon going down into dense bamboo-jungle on the hill-side near Nyaunggyo bungalow, but failed to obtain it. The general colour appeared to be dark vinous-brown on the upper parts and its size made it doubtful if it was *Alsocomus puniceus*. This note is placed on record in case *Ducula insignis griseicapilla* is later found breeding here.

Indian Rufous Turtle-Dove (Streptopelia orientalis meena). 403.

I saw several pairs near Nyaunggyo in April 1929 where it was probably breeding. I doubt if it occurs elsewhere in the district commonly except in dense jungle, though it is found in evergeen jungle at a much lower elevation in the Insein district.

[This specimen is *meena* of the *Fauna*, ed. ii ; *agricola* of Hartert.]

Burmese Spotted Dove (Streptopelia chinensis tigrina).

Very common and more or less resident. A nest found by me on 30th January, 1929, in an isolated cane-brake in the Nawin marshes contained three eggs, the only time I have ever seen a pigeon's or a dove's nest with such a number. Another nest found on 25th December, 1929, near Kyithe and containing newly-hatched young, was made of grass in a bush only about three feet from the ground.

Burmese Red Turtle-Dove (Œnopopelia tranquebarica humilis.) ♀ 255.

Oates never found this bird breeding, and my impression is that it is a winter visitor to Prome only, arriving in November and the majority leaving in March. During December and January, very large flocks can be seen.

Bar-tailed Cuckoo-Dove (Macropygia unchall tusalia).

As Oates did not apparently record it from anywhere west of the Sittang, it may be worth nothing that I saw no signs of it in April 1928 or 1929 in the Arakan Hills.

Burmese Jungle-Fowl (Gallus bankiva robinsoni).

Abundant. I do not think that in any part of Burma in which I have been, 'the breeding months are November to March'. (S. B. v. 298.) I have however seen young in Prome on one occasion with feathers beginning to sprout as early as 27th February 1928. In April, 1929, very large numbers of young ones were seen between 1st and 14th near Nyaunggyo. A few of these could just flutter ; others were newly hatched, the old hens being extremely tame. No cock-birds were seen accompanying broods. I have seen young birds that could just fly in mid-April 1925, at Thaton in the Tenasserim Division.

Burmese Silver Pheasant (Gennæus lineatus). 244, 273.

Oates suspected that both this species and *cuvieri* possibly occurred west of the Irrawaddy valley. Both the Silver Pheasants obtained for me, came from the low hills east of the Irrawaddy between Tarokmaw and the Inma swamp. I saw very few and could not describe its distribution.

Oates's Silver Pheasant (Gennæus lineatus cuvieri *apud*, Oates).

Oates remarks that it occurs 'over the whole of the Arakan Hills, extending, I think, quite down to the Irrawaddy river'. He shot one at Nyaungchidauk just where the Taungup road starts to ascend the *Yoma*. On 14th April, 1929, at Nyaunggyo in evergeen forest I met a female with a single newly-hatched chick. This bird had a pronounced crest and a dark chestnut tail with brown bars. It ran all round me in great excitement clucking in a low tone and ruffling out its feathers like a barn-door fowl. I saw one other hen bird come down to drink a few days earlier at the same stream, but otherwise saw none.

[I have not attempted to work out these pheasants, which are practically topotypes of *G. l. oatesi*, as the material in the British Museum is insufficient. The genus *Gennæus* is a very puzzling one and only carefully collected material with full data together with field notes can throw light on the subject. I stress this, as Mr. Stuart Baker has already stressed it (*Fauna*, ed. ii, V. p. 331), in order to bring home to the 'men on the spot', the only people who can help, the fact that, after all these years, not nearly enough of these Pheasants have been preserved and sent home for a proper understanding to be arrived at, though annually numbers must be killed.

The outline of the problem is as follows :—We have the Black-breasted Kalij of Assam *horsfieldi*, with black predominating on the back, extending into the north of Burma ; then the Silver Pheasant, *nycthemerus*, with white predominating on the back, extending from China into the east of Burma ; and lastly the Silver Pheasant of the *lineatus* type, with the feathers on the back silver-grey, due to the markings of black and white being about equal, extending into South Burma from Malay. Thus, taking Burma as a whole, we have, according to present ideas, one or more representatives of these three species, but their distribution is by no means clear, and *apparently* in some cases we have a representative of more than one species, side by side in the same district. If we could be sure of this, then we should know for certain that we have *three* species to deal with, each forming local races. If, however, no two forms are ever found in the same area, then it seems much more likely that in reality all three Kalij-Silver Pheasants are one species with numbers of races grading from black in the Himalayas to white in China.

Yet a third altèrnative remains as regards Burma ; have we a representative of each of the supposed species which, where they meet, hybridize ?

What we want to know therefore is this :—Can one or more recognizable forms be found in the same district ? If so, can they be obtained in (*a*) the same brood, (*b*) the same locality, (*c*) or is there an elevational difference in their distribution ? Are the same types of females always associated with the same types of males, or are there different types of females in the same area ? These are the sort of notes required with specimens, together with precise data as regards date, locality, colour of soft parts, etc.]

Blue-breasted Quail (Excalfactoria chinensis chinensis).

I saw a good many when shooting snipe in September and October 1928 in wet grass land on the Nawin marshes, where it probably bred. Not seen elsewhere.

Black-breasted Quail (Coturnix coromandelica).

Common 'in Northern Pegu' (Oates). I shot a good many especially in September and October 1928, but did not find it actually breeding.

Arakan Hill-Partridge (Arborophila rufogularis intermedia).

Oates obtained a number, all between Nyaungchidauk and Nyaunggyo. I should doubt it if it ever comes below 1,500 ft. on this side except in the rains, as the few I saw were nearly all in or near evergreen jungle, and seemed very partial to water.

Phayre's Burmese Francolin (Francolinus pintadeanus phayrei). ♀. 72.

Oates described it as confined to that portion of the Irrawaddy valley 'above Prome'. It was common 20 miles south of Prome and I got it near Padinbin on the south-west border of the district. It will probably be found on the forest outskirts down to Tharrawaddy. It is not uncommon but difficult to flush.

Burmese Button Quail (Turnix maculatus maculatus). ♀ 351, 393.

Common and probably resident. It was the only quail I saw in the Arakan Hills where I saw several at 3,000 ft. in pairs and small parties.

Eastern Bailon's Crake (Porzana pusilla). ♂ ♀ 143, 247.

I shot one at Letpanbu on 10th February and one at Prome on 5th March, 1929. These birds were very tame and running about close to me.

Oates only obtained one in many years.

Indian Blue-breasted Banded Rail (Hypotænidia striata gularis).

I did not meet this for certain, though Oates describes it as found over the whole Province. When snipe-shooting I twice flushed rails which I failed to secure.

Chinese White-breasted Water-hen (Amaurornis phœnicurus chinensis). ♂ 416.

Common : breeds.

Indian Moorhen (Gallinula chloropus indicus).

Oates apparently only got one, just outside the northern border of the Prome District in Thayetmyo. It was common in the Nawin marshes at Prome and I saw young ones late in September 1927.

The Water-Cock (Gallicrex cinerea).

I only saw one or two on the Nawin marshes at odd times. This is a bird which I have never seen in Burma except singly, and usually in very unexpected places.

Indian Purple Moorhen (Porphyrio poliocephalus).

Common and resident on all the big *Jheels* of the Irrawaddy valley.

Coot (Fulica atra atra).

Not seen by me. Oates did not apparently find it west of the Pegu *Yoma.*

Masked Finfoot (Heliopais personata).

Oates says he saw one killed on Inma, which is 25 miles south of Prome. In the *Fauna* he says 'I believe I once killed one on the Irrawaddy above Prome but did not preserve it.' As it was found very commonly in the lower reaches of the Myitmaka in Tharrawaddy, it almost certainly occurs on the upper reaches where the Myitmaka takes its source from the Inma Lake. I think I flushed more than one in the Nawin marshes but failed to obtain any. I also heard its note more than once.

Bronze-winged Jaçana (Metopidius indicus).

Common on the big lakes of the Irrawaddy valley, and in other suitable places; it undoubtedly breeds on Letpanbu and the Kywedalin swamps.

Pheasant-tailed Jaçana (Hydrophasianus chirurgus). Local name : *bi-gya.*

Oates considered this bird a permanent resident, but I got the impression that the bulk of those I saw on Letpanbu in December 1928 and January 1929 has passed on by March.

Painted Snipe (Rostratula benghalensis benghalensis).

It is noteworthy that Oates considered it rare and only obtained it at the end of the rains. Practically the only occasions on which I obtained it were in August and September while snipe-shooting on the Nawin marshes. Some seen then were distinctly immature and it almost certainly breeds on the Nawlin during the rains.

Indian Stone-Plover (Burhinus œdicnemus indicus).

I should not be surprised to find this bird breeding on the dry rolling hills on the north-eastern border, though the only one I ever saw was a single bird on 8th July, 1928, on the Nawin marshes, probably a passing migrant.

Great Stone-Plover (Esacus recurvirostris).

I looked for this bird carefully on the Irrawaddy and adjacent streams and failed to find it.

Large Indian Pratincole (Glareola maldivarum). 261.

Oates notes its arrival in February and found eggs in March, April and May. It breeds in several places along the Irrawaddy valley and in Prome my earliest records were early March. In 1928, there was a fairly large colony breeding on the Nawin marshes at Prome and I found a single incubated egg on 30th May, 1928. This colony had entirely vanished from the ground on 8th July, and did not return there in 1929 though I saw a single bird on 10th March, 1929, and a pair later on. I also found three or four pairs breeding on burnt stubble near Letpanbu and saw a nest with one incubated egg on 23rd March, 1929. In this situation the egg was extremely difficult to see, even when I knew its exact whereabouts. An unusual decoy trick practised by one sitting hen I watched was to leave the eggs aud nestle some yards away, exactly as if she was on her nest.

Small Indian Pratincole (Glareola lactea). 119, 200.

Breeds in very large numbers along the Irrawaddy valley. It appears to be, at any rate, a local migrant arriving in February and is very rare from July to January. Eggs can be found in some numbers from 20th March onwards, though I saw a young one on 21st March, 1929; colonies probably suffer severely from casualties, and I have found eggs as late as 16th May, shortly before the river rose. On this date I also saw almost fully-grown young, which can be distinguished in the field by the pale head and the absence of any black on the forehead.

I attempted to take thermometric records of eggs at 4 p.m. in March and found that a thermometer placed between the eggs registered 105-110 degrees. The usual clutch in this district is *two*, and at least 50 per cent of the nests are placed under isolated tufts of grass or other herbage for shade.

These birds have a very remarkable flight, occasionally seen when hawking low over the water at dusk. They appear to slide just above the surface with wings vibrating rapidly just above the back, the wings never seeming to be brought into a horizontal position at all.

Larus.

I saw no Gulls at all on the Irrawaddy in Prome District, though one might well have expected them, except two on 16th March, 1928, which I only got a distant view of. They may have been *brunneicephalus*.

Whiskered Tern (Chlidonias leucopareia). 295, 296.

Oates only observed it from November to May, and did not find it breeding. I did not get a chance to visit the big lakes in the rains and only saw three Whiskered Terns in two years. Two of these were shot on Letpanbu on 22nd March, 1929, and were feeding on a backwater with *S. aurantia*. These birds did not agree with the description in either Oates or Stuart Baker as regards their bill and legs. The mandibles were vinous black and inside of the mouth very dark, vinous red ; legs vinous red. The small size and mottled appearance of the head and nape distinguished them from other Terns on the wing.

On 5th and 15th October, 1929, I saw small parties of Whiskered Terns apparently migrating south across country near Tantabin in Insein District.

[Both are young birds in first winter plumage. Bills, exposed, 30–30·5 mm.; moulting tail, wings and body plumage.]

Indian River-Tern (Sterna aurantia).

The commonest Tern in the district and nests in very large colonies on suitable sand-banks. My impression is that most of them leave the district after the river rises in June, returning to their breeding haunts in January. The commonest clutch is two, and I have found eggs in numbers by 22nd March. The nest is always in a deep hollow, unlined, in sandy mud.

I watched a male on 22nd March, 1928, ' rolling ' in front of the female, with tail vertically erect and wings shuffling, in a manner very similar to the courtship of the Lapwing.

Black-bellied Tern (Sterna melanogaster).

This Tern is by no means uncommon and probably resident in small numbers, but I failed to find it breeding. It was certainly not breeding in one very large colony of *Rhyncops*, *S. aurantia* and *S. sinensis* in March, 1929. It appeared to be breeding near Letpankaya in March, 1928, and I saw several 8–10 miles up the Thaledan stream in April, 1928, but again saw nothing to prove that they were breeding. It is the only Tern which wanders far and wide fishing over the smaller streams and road-side ditches of the paddy plain.

White-shafted Ternlet (Sterna a. sinensis). 292.

I very much regret that I did not collect more Terns of this species. The only one shot, on an island off Padaung on 21st March, 1929, was, I think, undoubtedly breeding though it was just before dark and I had no time to look for the eggs. This specimen was from a small colony, of which every bird was flying round excitedly, exactly as if they had eggs. On 26th March, 1928, I saw one or two pairs on the same island which showed no signs of breeding. On 16th May, 1928, I found two nests each with two eggs of a Little Tern near Natmaw but did not identify the bird by shooting.

[This is no doubt *Sterna a. sinensis*. ♂ wg. 173 mm.; bill exposed 28·5 mm.; shafts of the first three primaries white. In the *Fauna*, ed. ii, it is said that this Tern breeds on the *coast* of Burma, whereas the Tern breeding on the *rivers* of Burma is *pusilla*. Assuming that *pusilla* differs from *sinensis*, this distribution cannot be correct. Robinson and Kloss give *sinensis* as the breeding bird in the Malay rivers.]

Indian Skimmer (Rhyncops albicollis). 293.

Oates says the normal clutch is four. The nests found by me never contained more than three and I think incubation starts as soon as the first egg is laid. I found three nests with birds sitting between 22nd and 26th March, 1928, and shot the male of a sitting hen on 21st March, 1929, finding two or three nests on the same date. The nest is always an irregular hollow on the bare sand far from other birds, and I noticed the hen constantly leaving the nest to fly round with her mate. A flock was migrating south down the river on 15th November, 1928.

Kentish Plover (Leucopolius alexandrinus alexandrinus). 115, 116, 314, 315, 316.

Oates never met it. I should say it was fairly common on the Irrawaddy from November to March. I came across a large flock near Tarokmaw on 4th February, all exceedingly tame and in very worn plumage, and another large gathering on 24th March in all stages of plumage but with a number of conspicuous chestnut-headed males. Saw nothing to suggest that they breed in the district.

[Two from Tarokmaw on 4th February in worn plumage and three from Thaledan on 24th March in very fresh dress. These I cannot separate from the typical race. Wg. 108–114 mm.; bill exposed, 15·5–17·5 mm.]

Little Ringed Plover (Charadrius d. dubius).

Oates (ii. 371) says he never saw it in 'Northern Pegu.' It is practically impossible to distinguish this and the next race in the field.

Jerdon's Little Ringed Plover (Charadrius d. jerdoni) ♂ ♀ ♂ 130, 248, 193.

Probably resident. All the Ringed Plovers obtained by me in February and March were of this race. They included one shot at dusk out of a party flying south overland which appeared to be migrating on 5th March, 1929. A Ringed Plover undoubtedly nests in the district, not only on the sand-banks of the Irrawaddy, but on the big shingle banks of the Thaledan and other streams, but I failed to find any nests or identify which race it was. At a short distance seen with glasses, this bird appears to have red eyes. One, which appeared to have a nest close to me at Letpankaya, kept sinking down and pretending to brood, shuffling its wings. This habit is noticeable in *hiaticula* during courtship. It is noteworthy that Oates did not find either this bird or *dubius* breeding.

Eastern Golden Plover (Pluvialis dominicus fulvus). ♀ 52, ♂ 242.

Oates remarks that there is one passage from September until November and December but a considerable number remain till April or May. I saw newly-arrived immigrants on 3rd October, 1928, and the earliest usually arrive in mid-September. From then on to March it is common in suitable country, a favourite haunt being the sandy *Kaing*-fields near Shwedaung.

[Two from Shwedaung on 22nd January and 2nd March. Both are young birds moulting into summer plumage; one of them retains a considerable amount of juvenile plumage on the upper parts.]

Spur-winged Plover (Hoplopterus ventralis).

Very common and resident. A considerable number breed up all the streams running out of the Arakan Hills. Oates did not find its nest and I found it the shyest and wariest bird to observe, unless a high bank or rise commanded the nesting-ground. I found one clutch incubated on 29th April, 1928, and another on 3rd March, 1929, both on open sand-flats: in neither case was there any attempt at a nest. Judging from parties of 5 and 6 seen in mid-April up the Thaledan and Mathon streams, the males either congregate in the breeding season like Mallard, or there are still unpaired birds passing through.

The crouching of the male bird, when alarmed, is very similar to a habit I noticed in the male Ringed-Plover in England in 1927.

Burmese Red-wattled Lapwing (Lobivanellus indicus atronuchalis).

Common and apparently resident, breeding mainly on paddy or fallow land.

Grey-headed Lapwing (Microsarcops cinereus).

Common in small parties from October to March and seen usually on the edges of fresh-water tanks. Oates records seeing large flocks at Inma.

Black-winged Stilt (Himantopus h. himantopus).

This bird is certainly not a 'resident' over the greater part of Burma (S. B. vi. 193). Oates considered it a winter immigrant only, and though I have seen it in several districts, I have never seen any sign of its breeding, except a small colony which I found in July 1921 near Kinu in the Shwebo district of Upper Burma.

There were six or seven pairs breeding at Kinu on what the Burmans call a 'soap bog', of such a nature that no money would tempt them into it, and I failed to obtain the eggs, though I saw with field-glasses from a distance at least one hen bird sitting. In Prome the Stilt was by no means common, and I only saw a few. One party of 12 which I saw in late September 1927 arriving over the hill from the north on to the Nawin marshes were, I think, certainly on passage.

Eastern Curlew (Numenius arquata lineatus).

I once heard a curlew passing down the Irrawaddy and Fielden got one (as also Whimbrel) at Thayetmyo. Oates never saw it away from the sea-coast neighbourhood.

Green Sandpiper (Tringa ochropus). ♂ 95.

Seen in small numbers from August to April. I think Oates's remark that he has generally found ' this Sandpiper in paddyfields in company with Snipe ' must refer to *T. glareola.*

Marsh-Sandpiper (T. stagnatilis).

I do not think I can possibly have confused this bird with the Greenshank which was common in Prome. Oates describes it as abundant in Pegu on the mudbanks of the larger rivers. I never saw it for certain.

Common Sandpiper (T. hypoleucus).

This bird is probably observable from July to May. I have seen it from late July to mid-April and it is common but rarely occurs except in ones or twos.

Wood Sandpiper (T. glareola) ♀ 96.

This is undoubtedly the common sandpiper of the district and is found everywhere from July 20th to mid-April wherever there is water or marshy ground. Snipe-shooting in this district and Henzada is nearly always complicated in August and September by the cloud of Wood-Sandpipers rising continually before one, out of which the rising Snipe has to be picked. It is very widely distributed along the Irrawaddy and even found on the bigger hill-streams at low altitudes. I have seen it as late as April 29th.

Redshank (Totanus totanus sub-sp. ?)

I shot one or two on Inma, but it was nowhere common and I did not see it along the Irrawaddy valley. [No specimens.]

Greenshank (Glottis nebularia).

Very common from September to March along the Irrawaddy. I have occasionally seen quite considerable flocks, and it is the commonest large wader.

Temminck's Stint (Erolia temmincki) ♂ ♀ 91, 64.

Common in flocks in September and October and a few remain until mid-April. Oates described it as ' comparatively rare ', but I think it will be found to be at least as common as *subminuta* which he thought the common stint of the Pegu Division.

Little Stint (Erolia m. minuta).

Oates described it as ' by no means common ' and apparently procured it only in South Pegu. I saw considerable numbers of Stints in flocks from mid-August onwards, but all those obtained were *temmincki* or *subminuta.*

Long-toed Stint (Erolia subminuta) ♀ ♂ 100, 109.

I shot several of these in February and March 1929 on Letpanbu and could always distinguish them from the other stints they were with by the much darker mottlings of the back. I shot it in mid-August in the Insein district in 1929.

[These are darker on the upper parts than *minuta* in similar winter dress due to the dark centres of the feathers having a larger area ; the tail feathers are darker and there is a well-defined grey streaked pectoral gorget. The toes are of course noticeably long and slender.]

Woodcock (Scolopax r. rusticola).

I can find no records of this bird in Prome, but it is probably overlooked. I had a report of some being seen two miles north of Inma in 1928 and thought I saw one on the edge of the Inma swamp. Mr. Claudius of the Burma Railways shot 3 near Hmawza, a few miles east of Prome, in December 1928.

Common or Fantail Snipe (Capella g. gallinago). ♂ 142.

Common but probably does not arrive in any numbers before December and is then confined to the *mayin* paddy on the Irrawaddy jheels. This bird's flight, note, reddish-brown appearance on the wing, and the places it frequents, all distinguish it at once from the Pintail.

[One, February 10th ; I can match this exactly with British birds.]

Pintail Snipe (Gallinago stenura). ♂ 6.

Mr. C. E. Milner, I. F. S., first brought to my notice the fact that a large number of Pintail Snipe obtained in September or October, are moulting their primaries and can barely fly. *In litt.* he writes of a day's shooting near Moulmein on 3rd September, 1927. 'A number of birds we killed with primaries only just sprouting : some could hardly flutter. . . As far as I can remember, these birds were all plump and all Pintail and showed 2, 3 or 4 bright blue quills in each wing.' I noticed much the same thing in Prome but did not preserve any. These birds sat very close and flew with difficulty and possibly they moult several of their primaries at once.

In 1927 and 1928, Pintail Snipe had arrived in some numbers on the Nawin marshes by 14th August and were abundant throughout September and October. Later on, when the ground dries up except for the jheels along the Irrawaddy, the bulk of those seen are Fantail. On the Inma lake I have shot this bird in the hottest part of the day out of the shade of bushes on baked mud a considerable distance from water. I noticed the same thing in the Upper Chindwin where one often flushed snipe out of burnt *Kaing* grass. The habit of spending the middle of the day on dry sandy ground far from water is one not uncommon with Snipe in Great Britain, especially in the eastern counties.

Spotted-billed Pelican (Pelecanus philippensis ?)

This bird must be rare in the district as I only saw one pelican in two years and did not get near enough to identify the species for certain.

Indian Large Cormorant (Phalacrocorax carbo sinensis).

I did not see this bird, and do not think it can have been at all common.

Little Cormorant (Phalacrocorax niger). ♂ 291.

A fair number from November to March along the river. This bird breeds in some numbers in palm trees at Kyangin and Seikktha in the Henzada district, a few miles south of the border in company with *B. coromandus* in the rains. I have not actually found it breeding in Prome.

Indian Darter (Anhinga melanogaster).

Common.

White Ibis (Threskiornis melanocephalus).

I saw a very large flock on Kywedalin south of Tarokmaw on 5th February, 1929, and should not be surprised to find it bred there.

White-necked Stork (Dissoura episcopa episcopa).

I saw a pair some way up the Mathon stream in mid-April 1928, which may have been breeding.

Eastern Purple Heron (Ardea purpurea manillensis).

Found in small numbers all along the Irrawaddy valley, as a rule singly. Very shy, though occasionally in high rushes birds will allow a very close approach.

Eastern Grey Heron (Ardea cinerea rectirostris).

Oates says it probably breeds but he never met it in the rains. I think it is resident in small numbers.

Eastern Large Egret (Herodias alba modesta).

Not uncommon but nearly always solitary. (The local name of all bitterns, pond herons, and egrets is *byaing*.)

Little Egret (Egretta g. garzetta).

In small numbers. Breeds.

Cattle-Egret (Bubulcus ibis coromandus).

This bird feeds largely on refuse near trenching grounds and slaughter-houses. It is the common egret of the district and nests in very large numbers in the heart of Prome town and in suitable places elsewhere. Stuart Baker says it starts to breed in July in Burma, but on 29th April, 1928, the Prome colony started to nest, the material (mainly tamarind twigs) being brought over the Irrawaddy. Pair after pair flew over my house on this errand. On 14th May I saw others building at Paukkaung.

Indian Pond-Heron (Ardeola grayii).

Very common everywhere. Breeds in company with *B. coromandus.*

Chinese Pond-Heron (Ardeola bacchus).

Oates apparently never discovered this Heron in Pegu, and I am inclined to doubt if it occurs as more than a straggler.

Little Green Heron (Butorides striatus javanicus).

Common on the wooded streams such as the Thaledan and Mathon in the Arakan foothills, where I saw it in April 1928.

Night Heron (Nycticorax n. nycticorax).

Common and probably resident. In the adjoining district of Henzada I found it breeding in July and August in close company with daylight feeders such as Cormorants and *B. coromandus*, so that the din of the colony never ceased day and night.

Malay Tiger-Bittern (Gorsachius m. melanolophus).

I saw one of these on the Mathon stream in the Arakan foothills in April 1928. It was shy but perched for a while in a tree, and gave me a good view of its chestnut-cinnamon back.

Yellow Bittern (Ixobrychus s. sinensis).

Not uncommon along the Irrawaddy valley. It is never seen except when flushed from swampy ground. It seemed to disappear almost entirely after October.

Chestnut Bittern (Ixobrychus cinnamomeus).

Oates describes it as ' nocturnal in its habits, shy, and very seldom seen.' Stuart Baker describes it as ' crepuscular and shy in its habits.' Like the Black Bittern, I consider this bird in Lower Burma is most conspicuous in the breeding season and pairs may frequently be seen flying round in wide circles in broad daylight, apparently ' displaying '. They also travel considerable distances from their feeding-grounds to their nests, and I have found it a matter of extreme difficulty to mark them down in consequence. This bird appears to be an immigrant in Prome from June to October and disappears as its breeding-haunts dry up.

Black Bittern (Dupetor f. flavicollis).

Stuart Baker and Oates remark that this bird is mainly ' nocturnal in its habits '. In the rains when it is presumably breeding, this is very far from being the case and on Hlawga Lake near Rangoon, individuals can be observed at all hours of the day flying strongly, at a considerable height, from their feeding-grounds to places at such a distance that I have been unable with powerful glasses to mark their destination. This bird is not uncommon in Prome and I have reason to think it breeds.

Nukhta or Comb Duck (Sarcidiornis melanotus) Local name: *Mauktin* (not *Maukton.* S. B. vi. 385).

Not very common as it falls an easy prey to every Burman with a gun. (It may be noted that Stuart Baker in *Indian Ducks* does not specially record this species from Upper Burma, but I have got it in Shwebo, Sagaing and the Upper Chindwin Districts.) Oates comments on its abundance at Inma. On 5th September, 1927, I saw a female with a brood of young ones at Prome which were well grown but still unable to fly. In the non-breeding season it resorts to sand-banks on the Irrawaddy.

White-winged Wood-Duck (Asarcornis scutulatus).

I have seen this bird in the Upper Chindwin and the Insein Districts of Burma. I have no reason to think it occurs in Prome and there is no water in the forest areas suitable for it, but Mr. Milner, I.F.S., informs me it was not uncommon in Tharrawaddy before the War. I saw a pair in Insein District in December 1925 and have several other records of its occurrence there. It may be worth recording that one which I had driven to me in the Upper Chindwin, when shot, *ran* at a great speed about 200 yards through dense jungle pursued by a terrier and when I eventually forced my way to it, I found it stretched out and feigning death, with the terrier standing over it. The drake and duck of two pairs seen here had separate notes, like Shelduck in the breeding season, the drake a low 'cronk', 'cronk', and the female a whistle, when on the wing.

Cotton-Teal (Nettapus coromandelianus). Local name :—*Kalagat.*

Very common from November to March on the big *jheels* of the Irrawaddy valley. I have not actually found it breeding, but in August 1927 saw two adults and a number of young birds which kept flying round an immense *nyaungbin* tree (ficus) in Paukkaung and settling on branches fifty or sixty feet from the ground. I have no doubt they had bred there.

Grey Geese (? Anser indicus).

The only geese ever seen by me in Prome were a gaggle which was reported in January, 1929, as frequenting the sand-banks and the pea-fields of the Irrawaddy valley near Shwedaung in January, 1929. I made more than one attempt to find them and eventually a gaggle of 20-25 birds flew past me about 100 yards distant on 3rd March, 1929. As I was trying to hide for a shot, I did not get my glasses on to them but think they were *indicus*. It is noteworthy that Oates had no record of geese in Lower Burma or Tenasserim at all. A recent enquiry in the Press has failed to obtain any such records from sportsmen.

Large Whistling-Teal (Dendrocygna fulva). Local name :—*Sisali.*

Oates notes that this was the only species he procured in Prome and Thayetmyo and I never found *javanica* in two years though it may occur in the south of the district. *Fulva* was common and undoubtedly breeding near Kyithe in the rains of 1928. Oates noted its abundance on the Inma Lake, where I obtained it.

Ruddy Sheldrake (Casarca ferruginea). Local name :—*Hintha.*

Stuart Baker (*Indian Ducks*, p. 141) says that it is 'a very rare straggler' to Southern Burma, which presumably means Tenasserim. It is common from November to March along the Irrawaddy valley throughout the district. Four seen flying south down the river at Prome in mid-November, 1928, were probably migrating.

It also occurs in some numbers on the Hlaing and Irrawaddy rivers on the borders of the Insein and Maübin districts.

Spot-Bill (Anas pœcilorhyncha sub-sp. ?).

I have never seen a Spot-bill in Prome and Oates never met with it in Pegu, nor did I ever see any duck which bore any resemblance to it. It is of course common in Upper Burma, particularly so in Sagaing and Shwebo. Mr. Milner, I.F.S., shot two on Kya-In just south of the Prome border in Tharrawaddy District on 8th January, 1910. He also saw two on the Ataran river, Moulmein, in December 1924.

Gadwall (Chaulelasmus streperus).

Oates never met it in Pegu, nor have I in Prome or elsewhere south of Shwebo District. Mr. E. B. Bloech informs me that he has never met it in many years, shooting in the southern part of the Pegu Division. Mr. Milner says he identified two small lots on the Ataran river (Moulmein) with glasses in December 1924 'without any possibility of doubt'. A recent enquiry made by me through the medium of the Press failed to elicit any other records of Gadwall in Lower Burma.

Shoveler (Spatula clypeata).

Stuart Baker (*Game Birds*, vol. i, p. 236), says that it has 'not yet been recorded from Pegu or Tenasserim'. I shot one on the Inma Lake on 24th December 1928, and saw one or two on the Letpanbu jheel in January 1929. It was certainly not common. Oates apparently never met it. Mr. Bloech, who knows the bird well, informs me that he has shot it a few miles north of Pegu town and also on the Hlaing river in the north of the Insein District. Mr. Milner saw a small party of Shoveler in Ataran (Moulmein) in 1924 of which he had a good view with field-glasses.

Wigeon (Mareca penelope).

Oates never met it and apparently disbelieved the statement that it occurred in the Pegu Division. Mr. Bloech informs me that he has shot it on Pyinbongyi, a few miles north of the town of Pegu, and also on the Hlaing river in the Insein District, but these were only isolated occurrences.

Common Teal (Nettion crecca). ♀ 126, 162.

Fairly common from November to February along the Irrawaddy.

Pintail (Dafila acuta acuta).

Oates (ii. 280) found it in some numbers at Inma and considered it the commonest of the larger migratory ducks. I saw considerable numbers on the Letpanbu jheel and the Irrawaddy in January and February 1929 and shot several.

Garganey (Querquedula querquedula). Local name: *Bè*.

As Oates remarks, it is the commonest duck in Lower Burma. The earliest seen by me were four on 28th September, 1928, on the Nawin, and a party near Shwedaung on 30th September of the same year. Very large numbers frequent some jheels on the Irrawaddy. I have seen odd birds as late as March, in which month it is sometimes very common in Upper Burma on migration.

Tufted Pochard (Nyroca fuligula fuligula). ♀ 141.

Oates had no record of this bird in Pegu or Tenasserim and there were apparently none up to 1921. I shot one out of a party on the Letpanbu jheel on 29th December, 1928, and saw a fair number on the same water. I also got another female on 10th February, 1929, in the same place.

Indian Little Grebe (Podiceps ruficollis capensis). 110, 111. Local name:—*Bè*.

A considerable number flocked on Letpanbu in January and February 1929. Oates also got the species in Prome and considered it a resident.

THE MAMMAL SURVEY OF THE EASTERN GHATS.

REPORT ON THE MONKEYS.

BY

R. I. POCOCK, F.R.S.

The Bonnet Macaques (*Macaca radiata*) and the Langurs (*Pithecus entellus*) recently obtained by Messrs. N. A. Baptista and V. S. La Personne on the Mammal Survey of the Eastern Ghats are sufficiently interesting to call for special notice. Their examination and comparison with examples previously secured by the Survey and already recorded in this Journal have incidentally brought to light some new facts demanding a revision of these monkeys in Southern India.

THE BONNET MACAQUE (*Macaca radiata*).[1]

The localities, dimensions and other particulars of the examples of this monkey, supplied by the collector, N. A. Baptista, are as follows :—

Locality and Sex		Length of Head and Body.	Length of Tail.	Total Length.	Weight.	Date.
Malakondapenta, Kurnool District	♂	1′ 8⅘″	1′ 10⅖″	3′ 7⅕″	12 lbs.	May 14
,, ,, ,,	♂	1′ 7⅗″	1′ 9⅘″	3′ 5⅖″	10 ,,	,, ,,
,, ,, ,,	♀	1′ 5⅗″	1′ 7⅘″	3′ 1⅖″	6½ ,,	,, ,,
Shevaroy Hills, 4,500′	♂	1′ 9⅗″	2′ 0⅖″	3′ 10 ″	14½ ,,	,, 19
Karumbapatti, Salem	♀	1′ 5⅗″	1′ 9 ″	3′ 2⅗″	...	Apr. 21

As will be explained in a subsequent paper, these skins, collected in April and May before the moult, are long and shaggy in the coat and pallid from fading, the distal portion of the hairs being greyish buff for a long distance. So far as their dimensions and weights are concerned they agree tolerably closely with other examples obtained by the Survey farther to the west and south in India ; and the particulars supplied show the average differences in size between the sexes.

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[1] By Blanford and many writers on Indian Monkeys this species was cited as *Macacus sinicus;* but Hinton and Wroughton (*Journ. Bomb. Nat. Hist. Soc.* 27, pp. 813–815, 1921), have shown that the name *sinicus* was given by Linnæus to its Ceylonese ally, the Toque Macaque, and that *radiata* is the earliest name that can be assigned to the Indian species. The correctness of this conclusion does not admit of a doubt.

Some dimensions in millimetres of the skulls are as follows :—

Locality and Sex	Total Length	Zygom. Width	Orbital Width	Length of Upper Molars	Lower Jaw
Malakondapenta, Kurnool. ♂ ad.	116	78	60	32	83
,, ,, ♂ subad.	110	73	58	31	76
,, ,, ♀ just ad.	95	65	52	28	65
Shevaroy Hills. ♂ just ad.	120	76	61	33	86
Salem. ♀ ad.	105	64	55	30	74

As may be seen, the Kurnool specimens are noticeably smaller than those from the Shevaroy Hills. But a few millimetres in a monkey's skull, although on paper they suggest a considerable difference, do not in reality amount to much. The Shevaroy specimens, male and female, are as large as any obtained by the Survey from other localities and preserved in the British Museum.

THE LANGURS

Pithecus entellus.

When I published the monographic revision of the Indian Langurs assigned to *Pithecus entellus* (*Journ. Bomb. Nat. Hist. Soc.*, Vol. XXXII, pp. 472–498, 1928), there were no available specimens of the species from the south-eastern area of the peninsula to compare with the large numbers of specimens obtained by the Mammal Survey in the central, western and southern districts. As was to be expected therefore, the examples of this species recently collected in the Eastern Ghats prove to be of exceptional interest and in a great measure bear out the opinion I expressed (p. 478) that 'further collections in areas not yet investigated, like the eastern parts of India from Orissa to south of Madras, will almost certainly bring to light new local races and will perhaps show that some of the forms here nominally distinguished are based upon characters not deserving that distinction.'

The following examples were secured : four females of various ages collected in April at Diguvametta in the Kurnool District, one Sault female collected in November in the Nallamalai Hills, 2,000′, d. Kurnool, one adult female collected in June at Dasarladoddi, the Palkonda Hills, 1,600′, and one adult male collected in July at Tirthamalai, Salem, 1,000′, in the Shevaroy Hills. Provisionally at all events I assign the Kurnool specimens to *Pithecus entellus anchises* and the Palkonda and Salem specimens to *Pithecus entellus pallipes*.

Pithecus entellus anchises, Blyth

Presbytis anchises, Blyth, *Journ. As. Soc., Bengal*, Vols. XIII, p. 470, 1844, and XVI, p. 733, 1847.

Pithecus entellus anchises, Pocock, *Journ. Bomb. Nat. Hist. Soc.*, Vol. XXXII, p. 488, 1928.

Blyth gave the name *anchises* to the skin of a langur from an unknown locality in the Deccan, describing it as like typical *entellus*, which has jet black hands and feet strongly contrasted with the paler arms and legs, but differing in having the hands mixed white and blackish and the feet whitish with dusky black above the base of the toes and on the terminal phalanges, the leg from the knee whitish and the coat very long.

The length of the coat in this specimen probably indicates that it was killed in mid-winter. But the chief interest of the skin lies in its supplying an intermediate stage in the tint of the hands and feet between typical *entellus* and typical *pallipes*.

In my paper, above quoted, I provisionally assigned to *anchises* some specimens obtained by the Survey, namely, a long-coated form collected in November in Hewra in Nimar, 1,000′, and two from Seone Malwa, C. P. (S. H. Prater). These monkeys, as was pointed out, are not exactly alike, nor do they agree precisely with the description of *anchises;* but the Nimar specimen is intermediate between typical *entellus* and typical *pallipes* (cf. infra) in the coloration of the hands and feet; and one at all events of the examples from Seone Malwa is intermediate between typical *entellus* and *achates* in having the head somewhat paler than the shoulders, and between these two black-handed and black-footed races and the pale-handed and pale-footed *pallipes* in the partially pale hands and feet.

In the specimens from Diguvametta in Kurnool the hands and feet are paler than in the specimen from Seone Malwa, but the fingers and toes are brown or black and sharply contrasted with the grey tint of the arms and legs which spreads on to the top of the hands and feet. In the oldest specimen the contrast is most marked, the blackness of the digits extending along the inner edge of the hand and foot almost to the wrist and ankle. This specimen, too, is greyer and less buffy on the back than the others and has a decidedly grey patch on the crown of the head, thus approaching the condition seen in typical *entellus* and *pallipes* in which the top of the head is the same or almost the same tint as the shoulders and back. In the others the crown shows scarcely a trace of grey and is slightly paler than the back and shoulders, thus approaching the condition seen in *achates*, *iulus*, *priamellus* and other more western and southern forms in which the buffy head is sharply contrasted with the dark shoulders and back. In all these Kurnool specimens the cheeks, ventral surface and inside of the limbs and buttocks are whitish grey, or, at most, faintly tinged with buff, but there is a very appreciable amount of buff on the chest, and only an inch or so of the tip of the tail is pale.

The example from the Nallamalai Range, 2,000′, shot in November, resembles those obtained in April at Diguvametta in the general hue of the upper side of the tail, the outside of the limbs; the hands and feet, and the crown is slightly paler than the shoulder, but the cheeks, buttocks, lower side and inside of the limbs are much more deeply suffused with buff. This skin is hardly distinguishable from the one, referred to above, from Hewra in Nimar, also procured in November, except that the coat is not so long. But, as explained below, this Langur differs from the Hewra specimen as well as from the other Kurnool examples in some cranial characters.

With the conversion of millimetres into English inches, the following table gives the weights and measurements taken in the flesh of the Kurnool examples :—

Locality and Sex	Head and Body	Tail	Total	Weight
Diguvametta, ♀ old ...	2′ $1\frac{3}{5}$″	3′ $3\frac{1}{5}$″	5′ $4\frac{4}{5}$″	24 lbs.
,, ♀ ad. ...	1′ $11\frac{1}{5}$″	3′ 2″	5′ $1\frac{1}{5}$″	23 ,,
,, ♀ yng. ad. ...	1′ $10\frac{2}{5}$″	3′ $1\frac{3}{5}$″	5′ 0″	22 ,,
Nallamalai, ♀ ad. ...	2′ 0″	2′ 11″	4′ 11″	...

These particulars agree very closely with those of the females of *pallipes* and *thersites* given below.

The skull measurements in millimetres of the same specimens are as follows :—

Locality and Sex	Total Length	Zygom. Width	Orbital Width	Length of Upper Molars
Diguvametta, ♀ old	108	85	69	34
,, ♀ ad.	105	81	66	35
,, ♀ yng. ad. ...	105	82	67	34
Nallamalai, ♀ ad.	106	85	66	30

As may be seen by the difference in the length of the upper molar series, these teeth are all smaller in the Nallamalai specimen, the first upper molar, penultimate tooth, being nearly 1 mm. shorter and narrower. The lower jaw too is different in shape owing to the greater development of its ascending ramus which has the lower and posterior edges more produced and the two rami are more widely divergent behind. In other characters the skulls are very similar: and on the evidence of one skull only from Nallamalai, nothing at present can be done with the differences beyond recording them.

Pithecus entellus pallipes, Blyth.

Semnopithecus pallipes, Blyth, *Ann. Mag. Nat. Hist.*, p. 312, 1844 (April).

Semnopithecus priam, Blyth, *Journ. As. Soc.*, *Bengal*, Vol. XIII, pp. 470 and 476, 1844 (after October).

Semnopithecus priamus, Blyth, *Journ. As. Soc.*, *Bengal*, Vol. XVI, pp. 732 and 1271, pl. 54, 1847 (in part); also Anderson and Blanford (in part).

When I described this race of *Pithecus entellus* two years ago, I followed Blyth, Anderson, Blanford and others in regarding the big langur, with the tufted head, which is found in Ceylon, as racially identical with the similar langur occurring in parts of southern India. And this course was justified by the close similarity in colour, size and other features between a number of examples from Ceylon and the only two Indian examples in the British Museum, namely, two adult males, one ticketed 50 miles S. of Trivandrum, Travancore (Col. F. W. Dawson), the other Arambo, at the foot of the Mahendragiri Range, Travancore (R. S. Pillay).

By the authors just quoted, and others, this Langur was called *Semnopithecus* or *Presbytis priamus*, although the earliest name Blyth gave to it was *pallipes*.

Now the typical examples, three in number, of *pallipes (priam)* came from the Coromandel Coast as stated by Blyth in 1843. Comparing this langur with *entellus (sensu stricto)*, he said it has 'nought of the yellowish tinge and more of the *lait* in the chocolat au lait' tint of the body, the hands and the feet being pale and resembling the rest of the limbs, and the whiskers and nape whitish. In 1846 he extended the range to Ceylon and, on the authority of Jerdon who told him the species was common at Tellicherry, to the Malabar Coast.

In 1879 Anderson altered and amplified Blyth's description of the Coromandel specimens declaring them to be pale ashy grey on the top of the head, the back, the outside of the arm, the upper part of the thigh and the tail, apart from its paler tip, whereas the sides of the head, the nape, the lower half of the thigh, the hands, feet, under side of the body and inside of the limbs are yellowish. Anderson also pointed out that Ceylonese specimens are much darker, being of a pale vinaceous brown on the back, the crown, the outside of the limbs and the tail. Herein lies the interest of the adult female collected by N. A. Baptista on June 29 at Dasarladoddi, 1,600 feet in the Palkonda Hills in Cuddapah and the adult male collected in July at Tirthamalai 1,000 feet in the Shevaroy Hills in Salem.

In the male, the general colour of the upper side from the crown of the head to the root of the tail is olive or brownish grey, the nape being buffy and in conjunction with the white cheeks and brow-band setting off the tufted crown. The outsides of the upper arm and thigh are the same tint as the back, but below the elbow and knee the limbs become gradually paler, the hand being pale grey and blending with the wrist, whereas on the leg the grey dies out at the ankle leaving the foot white with some darker hairs on the knuckles. The tail apart from the tip is blacker grey than the back ; and the under side, the inside of the limbs, like the whiskers, are whitish.

This male does not seem to differ in any respect from Blyth's brief description of *pallipes (priam)* ; but the female, which resembles it in the tint of the upper side, differs in having the brown of the crown paler and blending more with the frontal band and cheeks, which are not so white and the nape considerably paler, the chest and belly decidedly washed with buff, some black hairs on the fingers and more grey on the toes. In the tint of the pale parts at least it recalls the examples described by Anderson ; and since the Palkonda Range is midway between Kurnool to the north and Salem to the south, it is interesting to note that but for the tuft on the crown and the paler hands and feet in which it is more like the male from Salem, it is not separable from the examples from Kurnool assigned to *anchises.*

Both these specimens bear out Anderson's statement that Coromandel Coast Langurs with the tufted crown and hands and feet the same tint as the arms and legs are paler than Ceylonese examples exhibiting the same features. Now that I have seen Coromandel Coast examples, I think the two types represent distinct local races. The Coromandel form carries the very appropriate name *pallipes* and the Ceylon form the name *thersites* given by Blyth in 1847 to an isolated example, secured near Trincomalee, which he named because it had no tuft on the head. This tuft, however, although present in perhaps 95 per cent. of Ceylonese examples, is not invariably present. In addition to Blyth's record of its absence in the type of *thersites*, Kelaart recorded a second case and one of several specimens collected by Major E. W. Mayor for the Survey at Mankeni, near Trincomalee, constitutes a third.

As stated above, there are two examples of Langurs in the British Museum, from Travancore, which seem to be inseparable in colour from the Ceylon form, *thersites.* The question now arises : to which of the two races, *pallipes* or *therstes*, do the Langurs of this type inhabiting the Nilgiri Hills belong ? I have seen no skins from these hills, only two skulls certified by Blanford and Thomas as having been taken from head-skins referable to *priam*. But this opinion must be taken *cum grano* and left as uncertain until skins come to hand to settle the point.

When I discussed this Ceylonese Langur in 1928, I had only a few specimens for examination. Since then Mr. T. Fry has shown me a very large number of skins and skulls collected for the Survey in various parts of the island by Major E. W. Mayor. Some notes on this fine series may be useful.

Although the colour of these Langurs is subject to considerable variation, I have been unable definitely to associate the variations either with locality or season.

In a series collected at Mankeni in September and October the general colour of the back and head is typically dark-brown with a varying amount of paler buff-tipped hairs on the nape and a general absence of long glistening hairs on the body. The arms above are like the back, but below they lose the brown hue, the tint, passing into blackish grey on the hands. The thigh, apart from the pale buttock, is like the back, but below the knee the leg becomes paler and greyer passing gradually into the pale whitish grey foot. The tail also is like the back apart from its pale tip. The whiskers, under side and inside of the limbs, are greyish white.

One female, however, collected on September 28, is a good deal paler than the others, the hairs of the neck, shoulders and fore back having long buffy tips as if the coat was old and fading. This is the example referred to above which has no definite crest on the crown.

Several specimens collected at Cheddikulam in November and December generally resemble the darker specimens from Mankeni. But one adult male, shot on December 3, has more long glistening hairs on the shoulders and back. Another adult male has the cheeks, throat, chest and abdomen tinged with buff, like one of the specimens from Travancore. Two females, collected on December 2, are paler and shabbier looking in the coat.

A male from Kala Oya, shot on May 14, is dark brown like the September Mankeni specimens; but a female from Tammanewa, near Kala Oya, killed in the same month is paler than the Mankeni set, but the coat is in no sense deteriorating.

A female from Ranna (S. P.), collected on May 20, is also palish brown but the streaky look of the pelage suggests the imminence of the moult. A young female taken two days earlier at the same place is buffy grey in hue, the palest Ceylonese specimen observed.

An adult female, shot on June 10 at Kirinda (S. P.), has a markedly faded washed-out appearance, being '' straw coloured' over the shoulders with an abundance of very long rather coarse hairs with bleached glistening ends. But a male from Welligatta, shot on June 24, is in colour and texture of coat hardly distinguishable from the male shot at Cheddikulam on December 3. A female from Arucam Bay, shot on August 22, has a pale faded appearance.

These contradictory details show the difficulties in the way of understanding the changes in colour and coat of this Ceylonese Langur. The explanation of them will probably be reached only by an intensive study of the monkeys by some naturalist resident in the island.

The principal dimensions and weights, taken in the flesh, of some of the langurs assigned to *P. entellus pallipes* and *P. entellus thersites* are as follows:—

Locality and Sex	Length of Head and Body	Length of Tail	Total Length	Weight	—
Salem, E. Ghats, ♂ ad.	2′ $1\frac{1}{5}$″	3′ $3\frac{1}{5}$″	5′ $4\frac{2}{5}$″	37 lbs.	*pallipes.*
Arambo, Travancore, ♂ ad.	1′ $11\frac{3}{5}$″	2′ 8″	4′ $7\frac{3}{5}$″	...	...

Locality and Sex		Length of Head and Body	Length of Tail	Total Length	Weight	—
Cheddikulam, Ceylon,	♂ ad.	2′ 1″	3′ 0″	5′ 1″	25½ lbs.	*thersites.*
,, ,,	♂ ad.	1′ 11⅘″	2′ 8″	4′ 7⅘″	29½ ,,	,,
Mankeni, ,,	♂ ad.	2′ 0″	2′ 11⅗″	4′ 11⅗″	27½ ,,	,,
,, ,,	♂ ad.	1′ 10⅗″	2′ 8⅗″	4′ 7⅕″	24½ ,,	,,
Palkonda Hills, Cuddapah,	♀ ad.	1′ 11⅕″	3′ 1⅘″	5′ 1″	19½ ,,	*pallipes.*
Cheddikulam, Ceylon,	♀ ad.	1′ 10″	2′ 7″	4′ 5″	19 ,,	*thersites.*
Mankeni, ,,	♀ ad.	1′ 8⅘″	2′ 8⅗″	4′ 5⅖″	16 ,,	,,
,, ,,	♀ ad.	1′ 9″	2′ 5″	4′ 2″	14 ,,	,,
Arucam Bay, ,,	♀ ad.	1′ 10⅕″	2′ 6⅗″	4′ 4⅘″	...	,,

From this table it will be seen that the male of *pallipes* from Salem, although only slightly longer than the longest male of *thersites*, is considerably heavier than the heaviest and about 10 lbs. heavier than the average weight of the four males, the largest recorded, of the Ceylon race entered in the table. The figures bear out Blanford's guess that 'Madras specimens are probably larger than Ceylonese'.

Some cranial measurements in millimetres of the Indian specimens and a few of the Ceylonese are as follows:—

Locality and Sex		Total Length	Zygom. Width	Orbita Width	Length of Upper Molar	—
Salem, E. Ghats,	♂ ad.	127	102	80	36	*pallipes.*
Arambo, Travancore,	♂ ad.	123	95	78	32	*? thersites.*
Nilgiri Hills,	♂ ad.	122	97	78	34	*? pallipes.*
Valaichenai, Ceylon,	♂ ad.	119	87	71	29	*thersites.*
Cheddikulam,	♂ old.	118	91	76	30	,,
Mankeni,	♂ ad.	113	89	67	32	,,
,,	♂ ad.	109	87	72	30	,,
Palkonda Hills,	♀ ad.	106	81	67	33	*pallipes.*
Nilgiri Hills,	♀ ad.	102	84	65	30	*? pallipes.*
Mankeni,	♀ ad.	103	75	60	30	*thersites.*
Kala Oya,	♀ ad.	100	82	68	30	,,
Arucam Bay,	♀ ad.	100	77	60	28	,,

The skull of the example *pallipes* from Salem is noticeably bigger in all the dimensions recorded than the skulls of the males of *thersites*, the largest available for measurement. The skulls from the Nilgiri Hills and Travancore are nearly intermediate between the two. These two skulls differ extraordinarily in shape, as illustrated and described on p. 497 of my paper already quoted. The skull from Salem serves to link in a measure the differences between them. The forehead is flatter than in the Travancore skull, the nose is intermediate in prominence between the two, the occiput is not so uptilted and the mandible is not so massive and arcuate nor is its symphysis so long as in the example from the Nilgiris.

The teeth of *pallipes* are also bigger than of *thersites*. This is shown in the table by the greater length of the upper molar series in the male from Salem and the female from the Palkonda Hills as compared with that of the examples from Ceylon, and the first true molar, the penultimate tooth of the row, is nearly 1 mm. longer and broader in the Coromandel than in the Ceylonese specimens. In the Nilgiri Hill and Travancore specimens, the teeth are of the larger kind.

SOME BEAUTIFUL INDIAN TREES.

BY

E. BLATTER, S.J., Ph.D., F.L.S. AND W. S. MILLARD, F.Z.S.

PART VI.

(*With two coloured plates, two black and white plates and 5 diagrams.*)

THE CASSIAS.

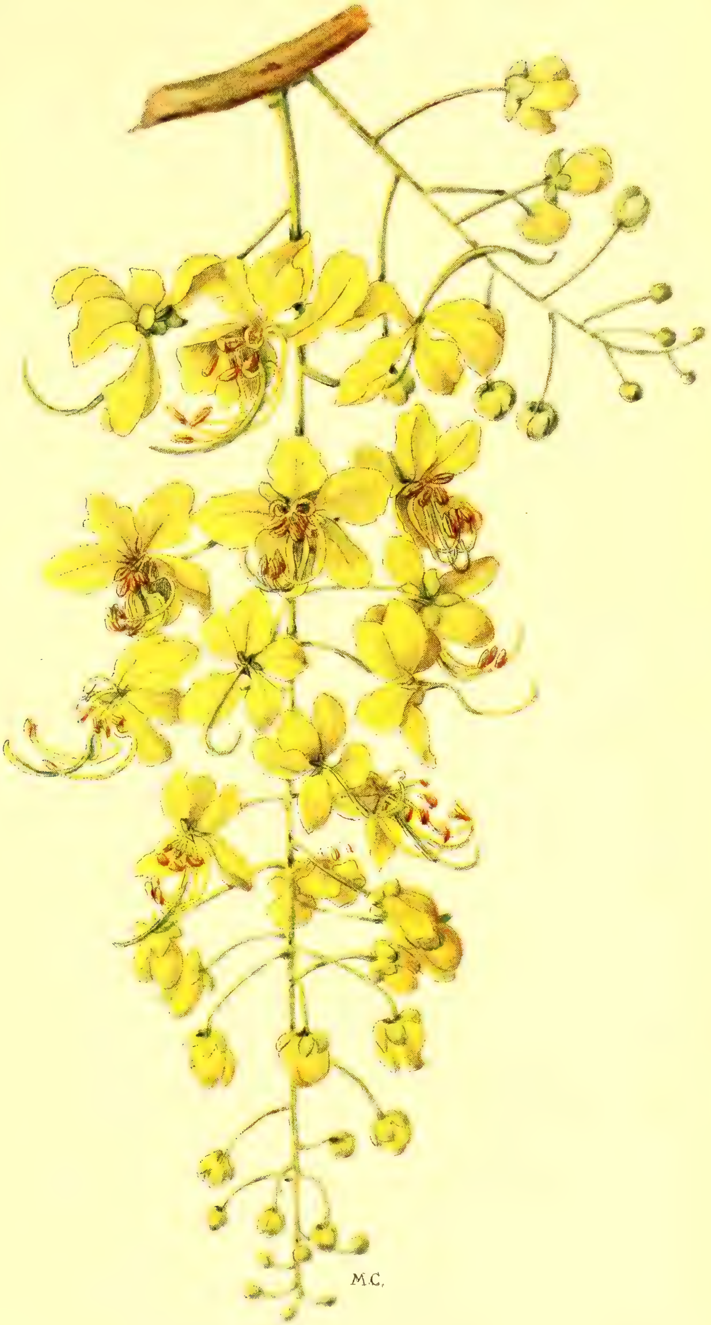
Cassia is an ancient Greek name for a genus which comprises some 400 different trees, shrubs and herbs, some of them famed for the beauty and profusion of their flowers, others for their medicinal value. The genus is included in the family *Cæsalpiniaceæ* which is named after the Italian botanist Andreas Cæsalpinus who flourished between 1519 and 1603. We propose to illustrate in colour 3 species of this genus which are noted for their showy flowers and to refer more briefly to a few others, which are as commonly cultivated.

THE INDIAN LABURNUM

Popular names : Indian Laburnum, Golden Shower, Pudding Pipe Tree, Purging Cassia (Engl.); Casse officinale, Casse Mondée (French); Röhrenkassie, Fistelkassie (Germ.); Cana fistula (Spanish); Amaltas, Girmalah (Hind., Duk.); Alash, Ali, Karangal, Kiar, Kaniar (Pb.); Raj-briksk, Kitola (Kumaon); Raj Briksha (Nepal); Chimkani (Sind); Sundali, Sonali, Amultas, Bandarlati (Beng.); Nuruic (Santal); Sonawir (Mal.,S.P.); Hari (Kol.); Dunras (Karwar); Rajbirij (Nepal); Sonalu (Garo); Bonurlate, Bonurlauri (Palamow); Sunaru (Ass.); Bandolat (Cachar); Sandari or Sunari (Uriya); Kitwali, Kitoli, Itola, Shimarra, Sim (N.W.F.P.); Warga (Oudh); Jaggarwah, Raila, Hirojah, Karkacha (C.P.); Raella (Baigas); Jaggra, Jagarua, Kambar, Rera (Gond); Banag, Bangru (Kukru); Bahava, Bhawa, Baya, Bawa (Mar.); Garmal or Garmals (Guj.); Konraih-kay, Skarak-konraih-kay, Kone (Tam.); Relu, Rela-rala, Rela-kayalu, Suvarnam (Tel.); Konnak-kaya (Mal.) Kakee (Kan.); Khiyar-shanbur, Katha-ul-Hind (Arab.); Khiyar-chanbar (Pers.); Suvarnaka, Aragbadha, Rajataru (Sans.); Ahalla or Ahilla (Sing.); Gnooshway, Gnoo-kyee (Burm.).

Cassia fistula Linn. Sp. Pl. (1753) 377. Cassia is the old Greek name of Dioscorides, *fistula* means a pipe alluding to the tubular shape of the fruit.

Description : This beautiful tree is frequently planted on city roads and avenues. Laburnum Road in Bombay derives its name from the number of Laburnums planted there.



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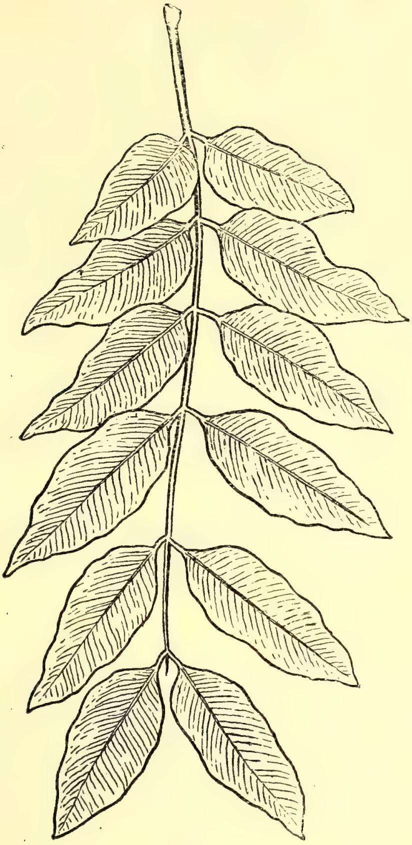
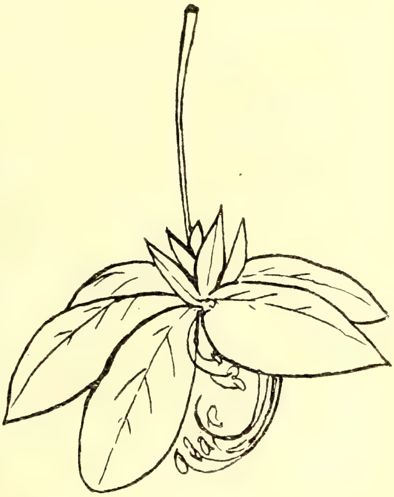
THE INDIAN LABURNUM.
Cassia fistula, Linn.
(½ nat. size)

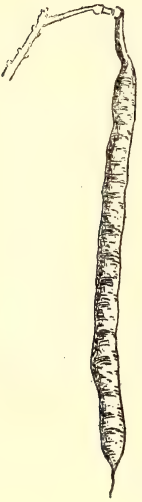
It is a more gracefully shaped tree than the English Laburnum. The Indian Laburnum is a small, upright tree which grows to a height of 20 or 30 ft. Its trunk is short, its branches slender, upright and spreading ; its foliage of the deepest green. In young trees the bark is smooth and ash-coloured. In older trees it becomes rough and dark brown. The tree has a compound leaf. The pubescent or slightly downy main-stalk or rachis of the leaf, 9 to 16 inches long, bears from 4 to 8 pairs of leaflets. Those growing about the base of the rachis are broadly ovate in shape, while the leaflets nearer its tip are more oblong and blunt ended. The leaflets grow opposite or nearly opposite one another. They are from 2 to 5 inches long and about 1½ to 3¾ inches broad. They are smooth above and covered with fine veins, more conspicuous on the under surface of the leaflet. The tender leaves are bright green and covered below with a silvery down. The erect branches and large leaves are distinctive in the Indian Laburnum and quite unlike the feathery, mimosa-like foliage and drooping branches so usual among the Cassia trees.



Few trees in India are more beautiful when in flower. Draped in streaming clusters of bright yellow blossoms, which hang from its branches in a golden shower, the tree suggests the English Laburnum. But it is infinitely more beautiful. Its drooping clusters of flowers are longer and the flowers themselves much larger. Each raceme or cluster is from 12 to 18 inches long. The cluster is made up of slender, thread-like stalks which hang downwards and



bear a profusion of large, fragrant, yellow flowers. The stalk of a flower is from 1½ to 2¼ inches long. It is slender, slightly hairy or quite smooth. The calyx is made of 5 tender green sepals which fold backwards on the stalk. There are 5 petals almost equal in size, almost oval in shape and very distinctly veined. They enclose 10 thread-like stamens all crowned with anthers. The 3 longest stamens are much curled and bear large, oblong anthers. There are 4 smaller median ones which are quite straight, the 3 remaining stamens are quite short and erect. Their anthers do not bear pollen. The pods of which there is always a great profusion are very conspicuous during leaf fall. They hang like so many straight pipes and have given the tree its Latin name of *fistula*. For a similar reason the Dutch, an unromantic people, call our Laburnum the Pudding-Pipe Tree while the Bengalee refers to the pods as 'Monkey Sticks'. The Pod is a straight cylinder. It is from a foot to 3 feet in length, and about an inch in thickness. It is quite smooth and dark green when young, turning dark brown and then black with age. Each pod contains from 40 to a 100 oval, shining, yellowish-brown seeds embedded in a dark coloured, sweetish pulp.



Distribution: Common in deciduous forests throughout the greater part of India and Burma, ascending to 4,000 ft. in the Himalaya; also in Ceylon. The tree is not gregarious, but is scattered in mixed deciduous forests, often of a somewhat open type: it occurs fairly frequently in sal forest. Sometimes it approaches gregariousness in localities frequented by monkeys. It is found on a variety of geological formations and will grow on poor shallow soil, as on the dry outer slopes of the Himalaya. In climatic requirements it shows a wide range. In its natural habitat the absolute maximum shade temperature varies from 100° to 120° F., the absolute minimum from 25° to 65° F., and the normal rainfall from 20 to 120 inches or more.

Leaf-shedding Flowering and Fruiting: The tree is leafless for a very short time, or hardly at all, between March and May, the new leaves appearing in April–May; these are bright green or sometimes a beautiful rich copper colour. The long pendulous racemes of large bright yellow flowers appear chiefly with the new leaves from April to June, but it is no uncommon thing to find the tree in flower even as late as September, particularly in dry years. The long cylindrical pods develop rapidly, reaching almost full length but not full thickness by October, when they are still soft and green. By November they are full-sized but still green and unripe; they commence ripening in December and continue ripening from January till March or April. The ripe pods hang for some time on the tree, commencing to fall about April–May continuing to fall in the following months: old pods may often be found on the trees in September or later along with the new half-grown green pods.

Photo by V. S. La Personne.

The Indian Laburnum (*Cassia fistula*).

Photo by C. McCann.

Flowering Branch of the Indian Laburnum (*Cassia fistula*).

Like many other hard leguminous seeds, those of *Cassia fistula* take some time to germinate, some lying a whole year in the ground before doing so, even if regularly watered. Boiling the seeds for about five minutes before sowing, has been found to give very good results in stimulating germination. Tests carried out at Dehra Dun showed that the seeds retain their vitality unimpaired for at least 2 years. It was found that seed from pods one year old germinated more quickly than that from fresh pods, though the percentage of sound seeds in the former may be low owing to insect attacks. (Ex Troup.)

Gardening : C. fistula stands a moderate amount of shade. It is not frost-hardy, and suffered severely in the great frost of 1905 in Northern India. In the abnormal drought of 1907 and 1908, which seriously affected the forests of Oudh, it proved to be decidedly hardy. It is not readily browsed, even by goats. It coppices vigorously and produces root-suckers from a root-system which is partly superficial. As already stated, it is not exacting as regards soil, and may be found on poor shallow soils.

Natural reproduction : The following facts have been established regarding the natural reproduction of this tree from seed :

1. Reproduction is effected mainly, and perhaps entirely, through the agency of animals (monkeys, jackals, bears, pigs, and possibly others), which break open the pods to eat the pulp and thus scatter the seeds or swallow and disseminate them.
2. The seed germinates during the rainy season, some lying dormant until the second or even the third rains.
3. Germination is favoured if the seed becomes buried, and to some extent if it is protected by a moderate growth of grass ; if the seed lies on the surface of the ground, much mortality takes place during germination owing to the destruction of the radicle by birds and insects, or to its drying up if exposed to the sun.
4. Many seedlings perish in heavy weed-growth owing to damping off during the rains.

Artificial reproduction : The seed germinates tardily, that kept for a year germinating more readily than fresh seed. The seed should be sown in seed-beds in drills about 10 inches apart in March or April, and regularly watered ; germination ordinarily takes place early in the rains, though some of the seed may lie dormant until the second year, germinating at different times from March onwards. Transplanting requires some care, but it can be carried out satisfactorily while the plants are still comparatively small during the first rains : basket-planting is the most satisfactory method, the seedlings being transferred to the baskets in the first rains and planted out in the second rains. (Troup.)

Uses : From the stem exudes a red juice which hardens into a gummy substance. This is generally known as *kamarkas*. Its economic uses, if any, are at present unknown to authors on Indian economic science, but it is stated to be astringent. The bark is used in tanning, chiefly along with Terminalia.

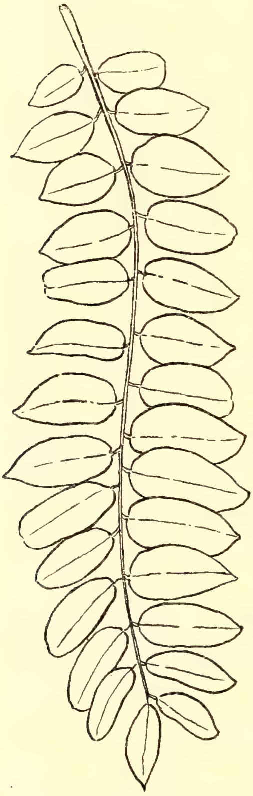
Medical Uses : In Hindu medicine the pulp is used as a cathartic; and the root is also described as a laxative, useful in fever, heart disease, retained excretions, biliousness, etc. In the Makhzan-El-Adwiya, the pulp is described as lenitive, useful for relieving thoracic obstructions and heat of blood, and is a safe aperient for children and women. Externally, it is said to be a good application for gout, rheumatism, etc. The flowers are made into a confection known as *Gul-kand* and viewed as a febrifuge. From 5 to 7 of the powdered seeds are prescribed as an emetic, and the shell of the pod rubbed down with saffron, sugar and rose-water, in difficult parturition. In the Konkan, the juice of the young leaves is used to cure ringworm and allay the irritation caused by the application of the marking-nut juice.

The root is given as a tonic and febrifuge. Dr. Irvine found the root to act as a strong purgative.

It is officinal in the Indian and British Pharmacopœas.

A poultice made of the leaves is said to relieve the chilblains which are common in Upper Sind. It has been beneficially used in facial paralysis and rheumatism when rubbed into the affected parts. Internally, it is given as a derivative in paralysis and brain affections.

By steam-distilling the finely powdered fruit of *Cassia fistula*, a dark yellow volatile oil, possessing a honey-like odour, is obtained. The oil forms an amorphous mass at ordinary temperatures, melts at 41°C., and has a faint acid reaction. The water which distils over with the oil, contains normal butyric acid.

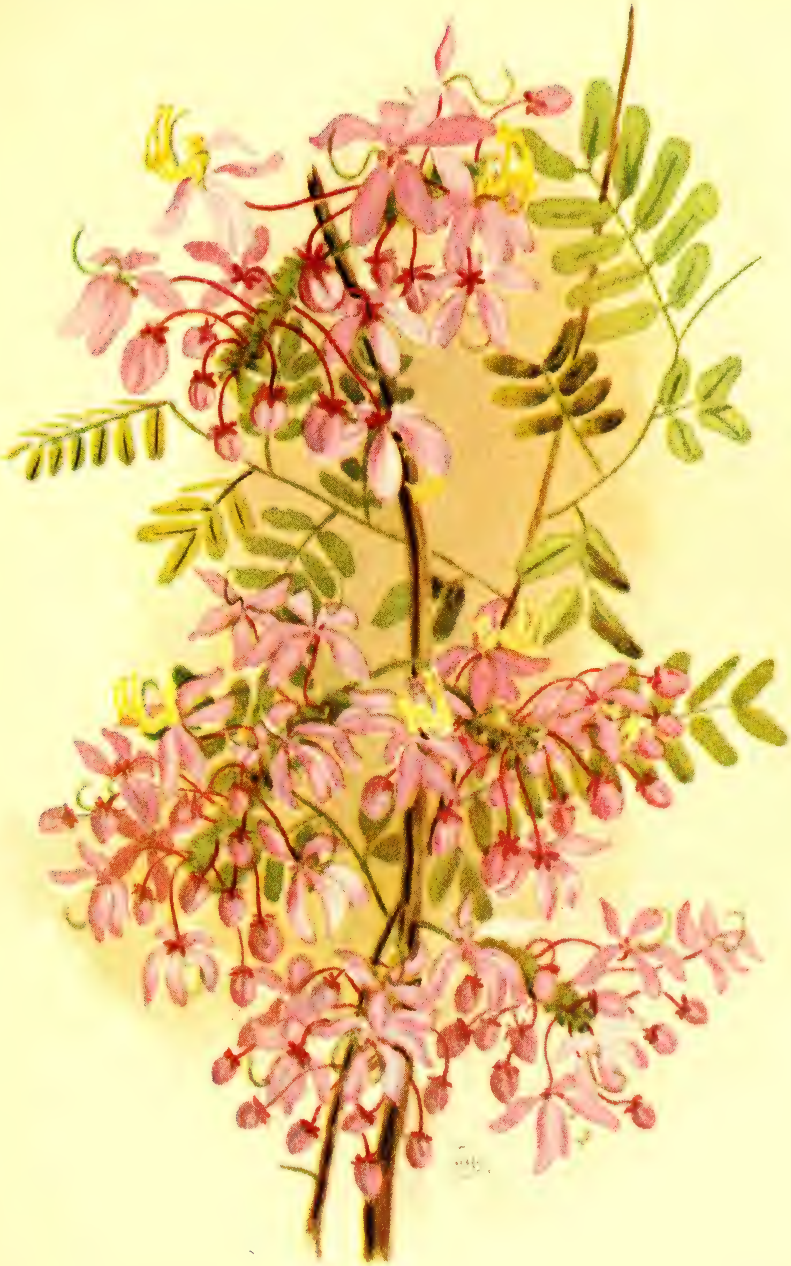


The Burmese Pink Cassia

Popular Names : Burmese Pink Cassia (Engl.); Ngushwe, Ngusat (Burm.).

Cassia renigera Wall., Cat. n. 5307. (*Renigera* means 'kidney-bearing' in allusion to the kidney-shaped stipules.)

Description : A small, medium sized tree growing about 18 to 20 ft. in height. The tree has a short trunk and a few upright branches which bear numerous slender, drooping branchlets. Clothed in feathery leaves, they reach downwards like great spreading plumes. The leaf is abruptly pinnate; there is no terminal leaflet to its main stalk. The young leaves spring from large kidney-shaped stipules which are quickly shed. The leaves grow from 4″ to a foot in length. A single leaf is composed of from 8–20 pairs of short-stalked leaflets. They are oblong in shape, rounded at the apex, downy and soft to the touch. Leaf-fall commences during December and by the end of



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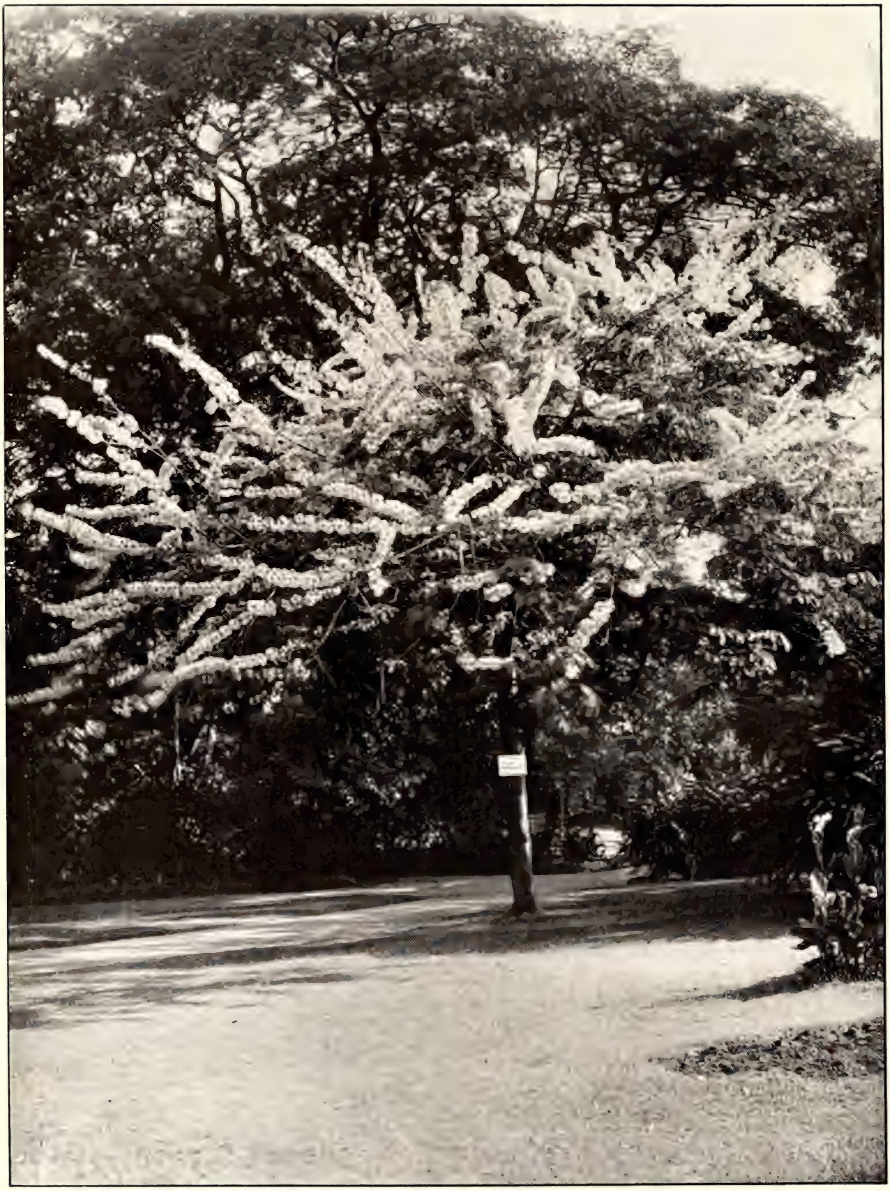
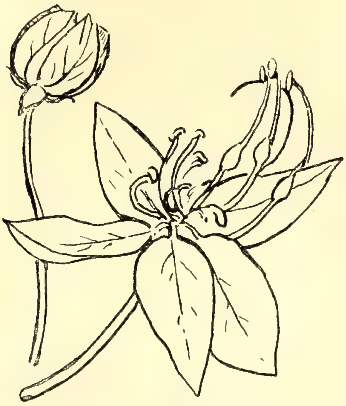
The Burmese Pink Cassia.
Cassia renigera, Wall.
(½ nat. size)



The Burmese Cassia (*Cassia renigera*) flowering in Victoria Gardens, Bombay.

March the tree is practically bare except for a few ragged leaves and the blackened pods which hang from its branches. In April the first buds appear. These open and in a few weeks the branches are smothered in a gorgeous profusion of pink and white blooms. Young leaves commence to spring up, making an assemblage of tender green leaves and masses of pink flowers which is very striking and beautiful. The flowers are large and showy. The older blooms fade from rose pink to white and give the clusters a variegated appearance. Each dense cluster of flowers is borne upon a short sturdy stem. The clusters arise singly or in pairs above the scars of the fallen leaves. Each flower-stalk springs from a drowny leaf-like bract. These stalks are deep red in colour and covered with fine white hairs. The sepals which make up the calyx of the flower are dull red externally and tender green within. The petals are a deep pink, oblong in shape and nearly an inch in length. As the flowers commence to fade, the tips of the petals turn white, the pink gradually receding and then fading out altogether leaving the flower white. There are ten stamens. The largest 3 are swollen at the centre and much curled and crowned with large tender, green anthers. There are 4 smaller median stamens and 3 quite small erect ones. All of these are capped with anthers. The style is long, thread like and deep red in colour. The pods are very similar to those of the Indian Laburnum. They are quite smooth, cylindrical and grow to 1 foot or 2 feet in length.



Flowering season : The main flowering season is from May to July. Leaf-fall commences during the cold weather and is completed by the end of March and the young leaves sprout in May, shortly after the tree is in full flower. Prain notes that the Shan Hills specimens have yellow flowers.

Distribution : Dry zone of Upper Burma, now introduced into India and the Malay States.

Gardening: The Burma Cassia which is so common in the Bombay City was first introduced by the Hon. Forbes Semphill who sent three plants to Mr. Millard from Rangoon about 1902. When the trees flowered, they were so beautiful that other specimens were obtained and, as the tree seeds quite freely, it has become quite common. The tree has not a long life but it grows rapidly. Trees planted from seed in a garden in Salsette in 1923 bore flowers for the first time in 1929 and in 1930 were about 18 feet in height. The tree is cultivated for ornament. It grows and flowers well even in moist climates like that of Rangoon, Singapore and Bombay although in its natural habitat this Cassia is accustomed to a dry climate and is capable of growing on comparatively poor soil.

(To be continued.)

INDIAN DRAGONFLIES.

BY

F. C. Fraser, Lt.-Col., i.m.s., f.e.s.

Part XXXVII.

(*With 1 plate and 2 text-figures.*)

(*Continued from page 738 of Volume XXXIV.*)

Sub-family : Platystictinae.

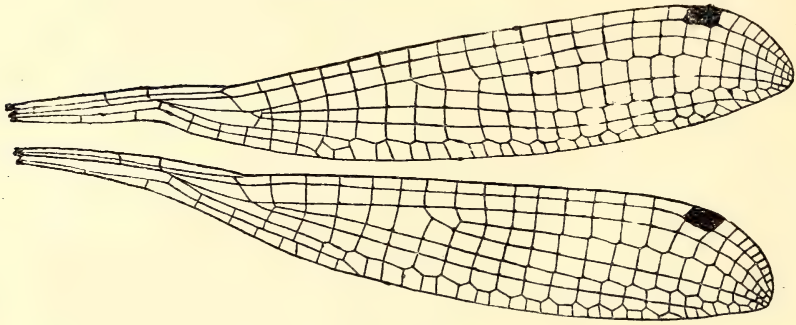


Fig. 1.

Wings of *Protosticta himalaica* Laid.

Genus *Platysticta* Selys. Bull. Acad. Belg. (2) x. p. 436 (1860) ; Id. ibid. pp. 144, 145 (1886).

Legion *Platysticta* Laid. Rec. Ind. Mus. vol. xiii, p. 323 (1917).

Sub-family *Platystictinæ* Laid. *Spolia Zeylanica*, vol. xii, pp. 300, 301 (1924).

Dragonflies of small size, coloured black or brown with white markings, or more rarely reddish marked with blue, rarely if ever metallic; resting with wings folded over dorsum ; wings very narrow, falcate at apex, hyaline or tipped with black at apices ; the nervure *ac* situated midway between the two antenodal nervures ; an accessory basal postcostal nervure always present and situated well proximad of *ac* ; petiolation beginning well distad of the nervure *ac;* the nervure *ab* reduced or absent and when present, extending from *ac* or the posterior border of wing to the posterior side of the discoidal cell ; *IA* absent ; *Cuii* markedly reduced, falling well short of middle of wings ; discoidal cell elongate, about four times as long as broad, the ends squared ; sectors of arc arising from the lower end of arc, separate or confluent for a short distance at origin ; individual cells mostly four-sided, more rarely five-sided ; *Riii* arising well distad of node, nearer node than pterostigma ; origin of $R4+5$ variable, either slightly proximad, at, or slightly distal of the oblique nervure descending from the subnode ; pterostigma short and broad, its costal side usually shorter than the posterior, its inner or proximal side oblique, its distal straight or slightly rounded ; no intercalated sectors present except *IRii.*

Abdomen of great length and very slender, in some genera twice or more than twice the length of hindwing, the relative lengths of segments 8, 9 and 10 variable in individual species ; anal appendages of male complex, variable in the species, the superiors usually forcipate and often chelate at the apices or spatulate ; inferior appendages more simplified, usually tapering to a point but spatulate in others. Vulvar scales very robust, extending beyond end of abdomen in most species and with a robust dorsal spine-like protuberance before the apex. Penile organ variable, with or without a frill or ridge on the dorsum, the end curling strongly over the stem which its terminal branches embrace.

Larvæ slender, cylindrical, furnished with three triquetral gills, mask flat, subquadrate, Gomphine-like, without setae, middle lobe cleft, lateral lobe robust, furnished with a long moveable hook, legs long and slim, breeding in torrential montane streams or seepages on the sides of hills in dense virgin jungle.

Distribution.—Tropical and neotropical. Within our limits, from Ceylon, Western Ghats, Northwestern India and Burma, in submontane and montane tracts, rarely at sea-level. Species are found haunting the banks of mountain streams of small size, often a mere trickle over rocks or a chain of pools below a spring on a steep jungly hillside in dense shade. Many species inhabit small caves among boulders and rocks beside streams where they exist in a perpetual twilight. In flight they are much given to hovering with the long attenuated abdomen held stiffly and horizontally out, whilst the insect advances or retires in a series of short jerky movements and, if approached head on, will retire backwards instead of reversing and heading off, this backward flying seeming to be accomplished as easily as the forward movement. Owing to their dull colouring, small size and dark surroundings, they are remarkably inconspicuous during flight and would be invisible were it not for the chain of white and blue spots on the abdomen seen to be moving stealthily about the dark recesses. The vivid blue identification marks on the terminal segments of the abdomen show up with remarkable conspicuousness even in the darkest retreats when the insect is at rest.

Ceylon is remarkably rich in Platystictas, whilst Continental India and Burma is equally rich in Protostictas and Drepanostictas.

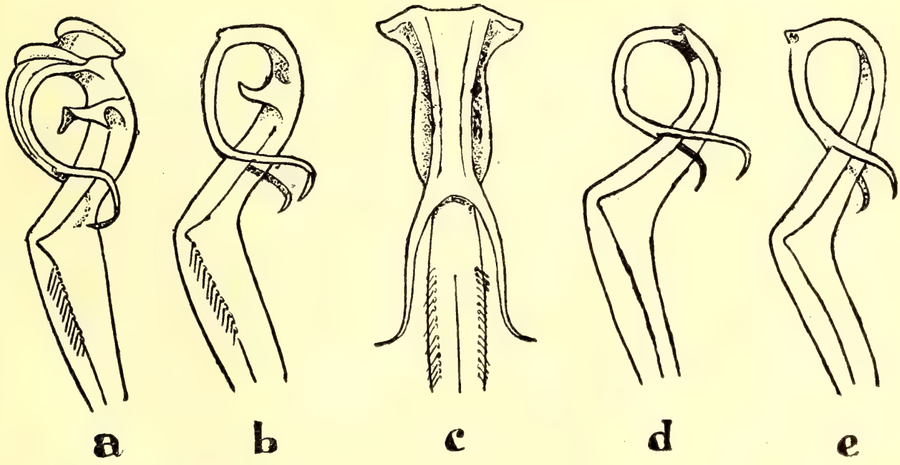


Fig. 2. Penile organs of,—

a. *Platysticta deccanensis* (Laid).
b. *Ceylonosticta hilaris* (Selys).
c. *Platysticta maculata* (Selys).
d. *Drepanosticta carmichaeli* (Laid).
e. *Protosticta gravelyi* (Laid).

Figure *a* shows the dorsal frill in the dorso-lateral position ; figure *b* the same in profile, figure *c* the penile organ viewed dorsally, whilst the two remaining figures show the organs viewed from the side ; note the absence of the dorsal frill in these.

The former group are sharply separated from the Indian forms by the penile organ which possesses a ridge on its dorsum, absent in the two latter groups, and I have employed this character as a means of classifying an otherwise difficult group of insects. Selys classed the whole of the Ceylon species as *Platysticta* and divided these into two subgenera from venational characters. To the first subgenus a south Indian species has to be added, whilst the second subgenus has been incorporated by Dr. Laidlaw in his genus *Drepanosticta*. The penile organ of this subgenus, so far as the Ceylon forms goes, differs from that of the Indian forms, which furnish the genotype and it is therefore clear that the two groups are not congeneric, although venationally they agree. This being the case I have here retained Laidlaw's genus *Drepanosticta* for the Indian species and have created a new genus *Ceylonosticta* for the Ceylon forms which possess Drepanosticta venation. The chain of evolution is probably *Protosticta*, *Drepanosticta*, *Ceylonosticta* and finally *Platysticta*, or the two latter genera may have evolved independently from *Protosticta* and on parallel lines to *Drepanosticta*.

The enormous length of the abdomen of these insects and the complex nature of the anal appendages, admirably adapted as they are for obtaining an enormous grip of the female prothorax, are probably coordinated with the function of oviposition, and I surmise that they enable the male to lower its mate into the swiftly flowing current of the streams they frequent, without fear of it being swept away. (See Fig. 2 Plate.)

Key to the Indian genera of *Platystictinæ*.

1	Ceylon forms ; penis with ridge on dorsum simulating a dorsal spine as seen in profile	2.
	Indian and Burmese forms ; penis without ridge on dorsum	3.
2	Sectors of arc separate and divergent from origin ; the nervure *I Riii* zigzagged almost from origin ...	*Platysticta.*
	Sectors confluent at and for some distance from origin ; the nervure *IRiii* not zigzagged	*Ceylonosticta.*
3	The nervure *ab* entirely absent	*Protosticta.*
	The nervure *ab* present	*Drepanosticta.*

Genus PROTOSTICTA Selys (1885)

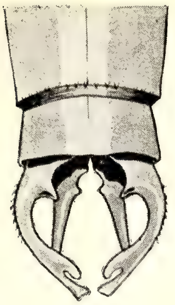
Protosticta Selys, C. R. Soc. Ent. Belg. xxix. p. cxlv, (1835); Id. Mem. Cour. xxxviii, p. 157 (1886); Laid. Rec. Ind. Mus. vol. xi, p. 391 (1915); Id. ibid. vol. xiii, pp. 339, 342 (1917) ; Fras. ibid. vol. xxiv, pp. 4 and 5 (1922); Id. ibid. vol. xxvi, p. 499 (1924).

Zygopterous dragonflies of small size and slender build with characters of the subfamily, coloured steely black marked with white and turquoise blue; wings hyaline, immaculate, long, narrow, falcate, cells mostly four-sided ; sectors of arc fused for a short distance from origin, thus arising from a common stalk ; *IRiii* straight, never zigzagged ; *R 4* + 5 arising at or a little proximad or distad of the oblique nervure descending from the subnode ; *ab* entirely absent. Abdomen of great length, especially in the male, double or more than double the length of hindwing (excepting *P. hearseyi*), segments 3 to 7 very slim and very long, segments 8 to 10 varying in length in the species and sexes, 9 sometimes as long as 8, 10 very short. Anal appendages about twice the length of segment 10, angulated downward and inwards at their middle and chelate at apices (except in *P. himalaica* and *P. uncatus* which are spatulate), inferiors simple, broad at base, tapering thereafter to a fine point, incurved or not. Vulvar scale as for sub-family. Larvæ as for sub-family but only those of *P. gravelyi* and *P. mortoni* known).

Genotype.—*Protosticta simplicinervis* Selys.

Distribution.—The Western Ghats of India from sea-level to 4,000 ft. and North-East India and Burma from 3,000 to 6,000 ft. Habits those of the subfamily; see also under species.

Species of this genus are remarkably local in distribution and in some cases have been found confined to one spot for years, streams close by, never rendering a single specimen ; this may be explained by their weak flight, although, some at least, *P. mortoni* and *P. gravelyi*, do wander afar from their habitats.



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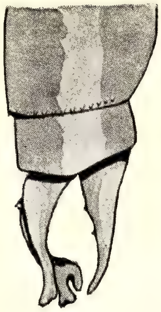

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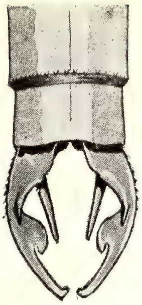

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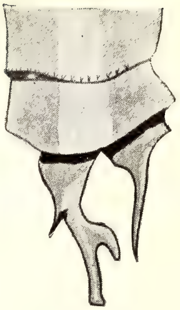

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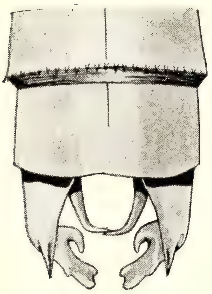

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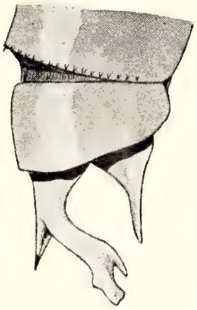

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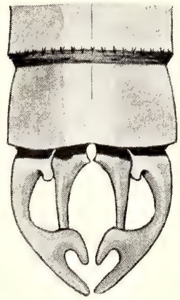

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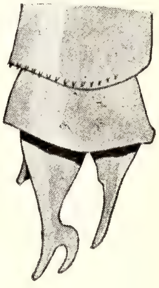

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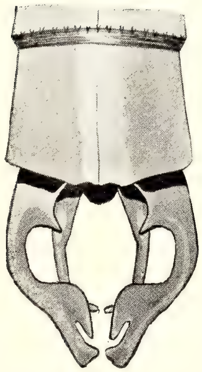

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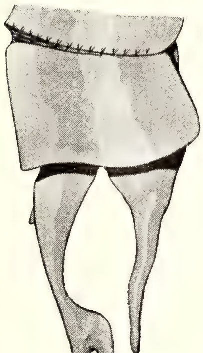

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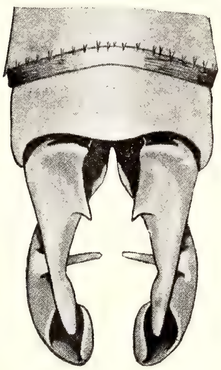

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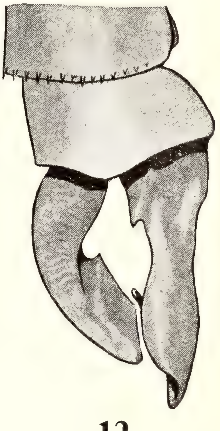


12

Explanation of Plate.

1. Anal appendages of *Protosticta hearseyi* Fraser, dorsal view.
2. The same seen from the right side.
3. The same of *Protosticta mortoni* Fraser, dorsal view.
4. The same seen from the right side.
5. The same of *Protosticta sanguinostigma* Fraser, dorsal view.
6. The same seen from the right side.
7. The same of *Protosticta gravelyi* Laidlaw, dorsal view.
8. The same seen from the right side.
9. The same of *Protosticta davenporti* sp. nov., dorsal view.
10. The same seen from the right side.
11. The same of *Protosticta himalaica* Laidlaw, dorsal view.
12. The same seen from the right side.

Camera lucida studies all drawn to the same scale.

Col. F. Wall has taken one species at light and I have on several occasions found specimens hovering about the windscreen of my car or actually coming inside. On one occasion I took a male in my bungalow, but this may have come to light the night before. As a rule though, species form definite and lasting colonies, restricted to small districts or even streams.

Key to species of genus *Protosticta*.

1	Small species with ground colouring cupreous and abdomen of both sexes considerably less than 40 mm. in length ; male and female of the same length ...	*P. hearseyi.*
	Larger species with ground colouring steely black and abdomen more than 40 mm. in length ; male always considerably longer than the female	2.
2	Pterostigma in both sexes blood red	*P. sanguinostigma.*
	Pterostigma in both sexes black	3.
3	Superior anal appendages chelate at apex	4.
	Superior anal appendages spatulate at apex	6.
4	Basal half of segment 8 pale blue with the middorsal carina finely black ; superior anal appendages with the claw-like arms narrow and of subequal length ...	*P. gravelyi.*
	Basal half of segment 8 pale blue, the middorsal carina not marked with black ; superior anal appendages varying as shown below	5.
5	Outer fork of superior anal appendages thickened, obtuse at apex and but slightly longer than the inner ...	*P. davanporti,*
	Outer fork of superior anal appendages very narrow, and nearly four times the length of inner	*P. mortonie.*
6	Inferior anal appendages with a long finger-like medial spine directed inwards	*P. himalaica.*
	Inferior anal appendages without an inner spine ...	*P. uncatus.*

Protosticta gravelyi Laidlaw.

Protosticta gravelyi Laid. Rec. Ind. Mus. xi, vol. pp. 389, 390, text-fig. 2. (1915) ; Id. ibid. vol. xiii, p. 342 (1917) ; Fras. ibid. vol. xvi, p. 499 (1924).

Protosticta stevensi Fras. Rec. Ind. Mus. vol. xxiv, pp. 7 and 8. Pl. 1, figs. 1, 2 and 7 (1923) ; Id. ibid. vol. xxvi, p. 499 (1924).

Male. Abdomen 46-49 mm. Hindwing 20-22 mm.

Head,–labium brownish black ; labrum turquoise blue, rather broadly bordered with black along its free margin ; clypeus pale turquoise blue ; frons, vertex and occiput glossy black ; eyes dark bottle green paling to pale greenish beneath.

Prothorax creamy white marked dorsally with a broad black triangle with its base occupying the greater part of posterior lobe and its apex tapering to the middle of the mid lobe.

Thorax steely glossy black marked with a broad oblique creamy white stripe on each side extending to the middle pair of legs, and a similar stripe on the posterior part of metepimeron extending on to the hinder pair of legs. Beneath marked with broad black stripes on each side which converge and fuse anteriorly.

Legs creamy white, the knees darker. Hind pair of femora occasionally marked on the extensor surface with a brown stripe.

Wings hyaline ; 13-14 postnodal nervures to forewings, 12-13 in the hind ; pterostigma black, nearly half as long again as broad, the costal side shorter than the posterior, outer border nearly straight, inner oblique ; *R 4 + 5* arising slightly or well distad of the level of subnode.

Abdomen black marked with white and turquoise blue as follows,—segments 1 and 2 white laterally, segment 3 with a narrow basal annule finely divided with black on the dorsum, segments 4 to 7 with broad basal annules gradually broadening as far as 7 and partially divided on the middorsal carina by the ground colour, segment 8 with nearly its basal half turquoise blue, this extending apicad on the sides and ventrally but divided along the middorsal carina by a fine black line, segments 9 and 10 unmarked. Segment 9 double the length of 10, and 8 double the length of 9.

Anal appendages black (figures 7 and 8 Pl.) Superiors forcipate, chelate, half as long again as segment 10, broad at base where they are furnished with an inner and dorsal blunt rounded tooth, then tapering, but again expanded at the apical half into a 'finger-and-thumb' like structure, the finger process being a little longer than the thumb. Inferior appendages about three-fourths the length of superiors, broad and conical at base, then tapering rather rapidly to apex, furnished with an inner stout spine at base.

Female. Abdomen 33-35 mm. Hindwing 19-23 mm.

Very similar to the male but shorter and more robustly built, differs as follows,—black bordering of labrum broader ; eyes, in the living state with a diffuse white spot on the outer sides ; wings with 13-14 postnodal nervures to all wings. Abdomen shorter and stouter, especially from segment 7 to the anal end, the former segment nearly three times as long as 8, which is itself actually shorter than segment 9, the latter segment being three times the length of segment 10. The basal annule on segment 7 occupying only about one-fifth the length of segment and often interrupted on the dorsum, whilst 8 is unmarked save for a large white spot situated at the base on each side ; segments 9 and 10 immaculate but the former sometimes with a large lateral white spot. Anal appendages black, barely as long as segment 10, broad, conical, pointed at apex.

Distribution.—This species is the most widely distributed of all the Protostictas and occurs in many ravines from 2,000 to 4,000 ft. in many parts of the Western Ghats. It occurs in the Nilgiri Hills on both sides of the plateau, at Kallar, Burliyar and Gudalur, from May to June. In Malabar and Cochin it occurs in the Vayitri, Nilambur and Kavalai Ghats from May to June and again in September and October. It may be found lurking amongst rocks and ferns or in the dark tunnels formed by trees and shrubs overhanging torrential beds. In flight it holds its abdomen rigidly horizontal and advances in short jerks on its objective or reverses and flies backwards with equal ease, and is visible in the prevailing gloom only by the chain of white dots marking the bases of the segments. Type in Indian Museum, paratypes in British Museum, etc.

Some confusion has arisen over this species probably due to the fact that the type is immature and in very poor condition, with its abdomen crumpled up and appendages distorted. The marking on segment 8 has been given as that for 7, and the length of the abdomen has been given as that for the body. It was due to these excusable errors that ***P.stevensi*** was described by myself as a separate species. Since then I have had an opportunity of examining the type and female cotype and making new measurements. From this I find that *gravelyi* and ***stevensi*** are conspecific, Dr. Laidlaw's name having priority. The female I find is really that of *P. mortoni* ; it is to be remembered that when Dr. Laidlaw described these sexes, *P.gravelyi* represented the only Indian Protosticta then known, so that it was but natural he should consider the insects as the two sexes of one species, although taken in different localities.

Protosticta davenporti sp. nov.

Male. Abdomen 43-45 mm. Hindwing 23-24 mm.

Very similar to *P. gravelyi* from which it differs however by its much more robust build, this character being very striking when the insects are confronted. It is then seen that although the abdomen of *P. gravelyi* is longer, the head and thorax are of much slighter build and the wings are correspondingly shorter and narrower. The anal appendages although built on the same plan as those of *P.gravelyi*, have very marked differences.

Head, prothorax and thorax similar to *P gravelyi* but the markings more definitely bluish and the black dorsal marking of the prothorax restricted to the middle portion of the posterior lobe and ending as two points on the dorsum of the mid lobe.

Wings broader and longer ; pterostigma black, half as long again as broad, 14-15 postnodal nervures to forewings, 13-14 in the hind, (One specimen is remarkable in possessing four postcostal nervures in one of its wings, instead of the usual nervure *ac* and one additional postcostal) ; *R*4 + 5 arising opposite the level of subnode.

Abdomen black with the sides of segments 1 and 2 and the base of 3 bluish white ; segments 4 to 7 with narrow white basal annules which broaden apicad on the sides ; segment 8 with its basal third or half pale turquoise blue, this colour extending nearly to apex of segment laterally, but not divided on the middorsum as in *P. gravelyi.* The blue annule on this segment separated from the extreme base by a narrow triangle of black. Segments 9 and 10 immaculate and of the same relative lengths as in *P. gravelyi.*

Legs differing from the latter species by the femora black, the two hinder pairs white on the extensor surfaces and the middle pair with a large white distal spot at the distal ends on the outer side ; tibiæ dirty white, tarsus black.

Anal appendages black. (Pl. figs. 9 and 10.) Superiors forcipate, chelate, half as long again as segment 10, broad at base where they present a large inner sub-basal pointed tooth or spine, then narrowing abruptly and expanding again in the distal half to form a 'finger-and-thumb' like structure which differs from that of *P. gravelyi* by the finger process shorter and broader and with its apex broadened and flexed inwards to almost meet the apex of the thumb ; outer border of this appendage very sinuous, not gradually curved as in the last species. Inferior appendages broad at base, then tapered gradually to apex, slightly sinuous as seen in profile but with a distinct angulation about the middle as seen from above and with the apical fourth curled rather abruptly inwards ; nearly as long as superior appendages.

Distribution.—Confined so far as known to the Annaimallai and Mudis Hills at elevations of about 3,000 to 4,000 ft. and found in similar situations to the last species. The shape of the anal appendages shown in Pl. figs. 9 and 10, will serve to distinguish this fine insect from all other Protostictas. Type in British Museum paratypes in author's collection.

Protosticta sanguinostigma, Fraser.

Protosticta sanguinostigma, Fras. Rec. Ind. Mus. vol. xxiv, pp. 6 and 7, Pl. 1, figs. 5 and 6 (1922) ; Id ibid. vol. xxvi, p. 499 (1924).

Protosticta cerinostigma, Fras. (*var.*) Ibid. vol. xxvi, pp. 499, 509 (1924).

Male. Abdomen 42–45 mm. Hindwing 22–26 mm.

Head,—labium yellowish ; labrum turquoise blue narrowly bordered with black along the free margin ; clypeus turquoise blue ; frons, vertex and occiput glossy black, the latter marked with a transverse coppery brown fascia ; eyes bottle green, pale greenish blue below, these two colours separated by an equatorial band of blackish brown which crosses the head from above and behind somewhat obliquely.

Prothorax black on dorsum, whitish laterally, the mid lobe marked with a large oval blue spot on each side the middle line.

Thorax glossy steely or bronzed black, pale blue on the sides where a narrow oblique stripe of black bordered with brown traverses the anterior border of the metepimeron. Beneath immaculate, thus contrasting strongly with the two former species.

Legs pale yellow, femora lined with black on extensor surface and with a broad brown annule at the distal ends ; tibiæ clouded or stippled with brown ; tarsi dark brown.

Wings hyaline ; pterostigma blood red, covers one cell, of similar shape to the former species ; 15–18 postnodal nervures to forewings, 14–15 in the hind ; *R*4 + 5 arising slightly or well distad of the oblique nervure descending from the subnode.

Abdomen blackish brown on dorsum, paler on the sides, marked with white and pale turquoise blue ; segments 1 and 2 white laterally, segments 3 to 6 with broad distal black annules, segment 3 with a very narrow obscure white annule at the base, segments 4 to 7 with broader annules gradually increasing in depth from 4 to 7, segment 8 turquoise blue, its apical border black, this colour continued basad as a gradually narrowing tongue of black along the middorsal carina as far as the base of segment, segments 9 and 10 entirely black. Segment 7 very long and broadening apicad, segment 8 only slightly longer than 9, which is nearly three times the length of 10.

Anal appendages black (Pl. figs. 5 and 6) ; superiors forcipate, chelate, seen from above appearing only slightly longer than segment 10, but in profile owing to the ends being bent strongly downward, seen to be nearly twice the length of the segment, very broad at base, then tapering and inclined strongly down and inward to end in the usual 'finger-and-thumb' process, the finger portion much broader and longer than the thumb and notched at its apex which is broad and blunt ; the thumb portion curled in to nearly meet the opposing process ; dorsally the basal portion continued horizontally back to end in a robust pointed spine. Inferior appendages about three fourths the length of superiors, broad at base, then rapidly tapering to a fine point, the apical fourth angulated strongly inwards to meet or overlap its fellow on the opposite side.

Female. Abdomen 39 mm. Hindwing 26 mm.

Very similar to the male but of much shorter and stouter build, differs as follows,—the equatorial belt of black encircling the eye much better defined ; prothorax a dirty white laterally and without the middorsal blue spots. Wings similar to the male, pterostigma blood red ; 16–17 postnodal nervures to forewings, 14-15 in the hind, *R4+5* arising at the same level or nearer to the subnode.

Abdomen black marked with white and turquoise blue as follows,—segment 1 with a blue spot on each side, 2 with a lateral blue spot at the base prolonged laterally apicad and ventrad, segment 3 with its middle two-thirds laterally and beneath brownish white, 4 similar and with a narrow whitish basal annule, 5 and 6 with well-marked white basal annules, the ventro-lateral markings more obscure, segment 7 with its basal third turquoise blue, the black not continued basad along the middorsal carina as in the male, remaining segments entirely black.

Anal appendages black, barely as long as segment 10, small, conical, triangular processes. Vulvar scale robust, extending beyond end of abdomen.

Distribution.—Nilgiri Hills, Coorg and Malabar Wynaad. Specimens from the two latter districts are much smaller than those from the Nilgiris. In the latter district it is moderately common in the Burliyar ravine, Mettupalayam Ghat at 1,500 ft., but very rare on the opposite side of the plateau, where the variety *cerinogstigma* was found. (Structurally this latter insect does not differ from type so that I consider it to be merely a variety.) In Coorg it is located to Hallery, whilst in the Wynaad, it appears to be restricted to the Vayitri and Nilambur Ghats from May to October. The blood red pterostigma and the shape of the anal appendages, relative lengths of the terminal abdominal segments, etc. will serve to differentiate this beautiful species from all other Protostictas. Type in the British Museum.

Protosticta mortoni Fraser.

Protosticta mortoni Fras. Rec. Ind. Mus. vol. xxvi, pp. 500, 501 (1924).

Protosticta gravelyi Laid. (*mortoni* nec *gravelyi*) ibid, vol. xiii, p. 342 (Female) (1917).

Male. Abdomen 41–43 mm. Hindwing 20 mm.

Head,-labium blackish brown ; labrum turquoise blue moderately broadly bordered with black along its free margin ; clypeus turquoise blue ; vertex and occiput glossy steely or bronzed black ; frons black ; eyes ultramine blue capped with black above, paler blue beneath.

Prothorax pale blue except the posterior lobe which is black.

Thorax steely black on dorsum, pale blue laterally, traversed along the postero-lateral suture by a broad black stripe ; beneath thorax yellowish marked by two thick black stripes which converge and become confluent anteriorly as in *P. gravelyi*.

Legs white, the knees and femora sparcely stippled with black.

Wings hyaline : pterostigma black framed narrowly in pale brown and this again framed within thick black nervures ; 13 postnodal nervures to forewings, 12 in the hind ; *R4+5* arising distad the oblique nervure descending from the subnode.

Abdomen black marked with turquoise blue and white as follows,—segment 1 blue laterally, segment 2 with the basal two-thirds of the sides white, 3 with a narrow white basal annule prolonged for a short distance along the sides and narrowly interrupted on the dorsum, segments 4–7 with broad white basal annules occupying about one-sixth the length of segments and prolonged along the sides and ventrum, segment 8 with the basal half turquoise blue but this colour prolonged along the sides nearly as far as the apical end of segment and separated from the base by a narrow black annule; segments 9 and 10 entirely black. Segment 7 very long, 8 about one-third the length of 7 (In the original description, this segment was given in error as slightly more than one-fourth the length of segment 7, whereas 9 was intended), segment 9 rather more than half the length of 8 and slightly more than twice the length of 10.

Anal appendages black (Pl. figs. 3 and 4); superiors forcipate, chelate, about twice the length of segment 10, broad at base, then constricted and curved downwards and again dilated in the first part of the apical half to form the usual 'finger-and-thumb' process, the finger thrice the length of the thumb and with its extreme end angulated inward, the thumb portion short and stout; dorsally the basal portion ending in a robust pointed tooth or spine very much as seen in *P. sauguinostigma.* Inferior appendages very broad at base, then abruptly narrowed, curled gently in and tapered to a fine point, about three-fourths the length of superiors.

Female. Abdomen 32-33 mm. Hindwing 19-20 mm.

Very similar to the male but much shorter and more robust. Markings differ only on the abdomen where segment 7 has a blue basal annule occupying from one-third to one-fourth the length of segment, and segment 8 has a large baso-lateral whitish spot on each side, 9 and 10 entirely black. Segment 7 is rather more than four times the length of segment 8, which is itself slightly shorter than segment 9, the latter being nearly four times the length of 10.

Anal appendages very short, barely the length of segment 10, conical pointed, black. Vulvar scale very robust, extending beyond end of abdomen.

Distribution.—Very local, usually found in isolated colonies. The original colony in the Sampaji Ghat, Coorg, was restricted to one part of a tributary of the Sampaji river. Since then I have found other colonies along the foot of the Western Ghats in Malabar and a single female has been taken on Salsette Island by Mr. Prater. The species thus differs from all others by being found at or near sea-level. The colouring of the prothorax forms a ready means of identification whilst the appendages will serve to separate it from all other species. As mentioned above, the female described by Dr. Laidlaw as that of *P. gravelyi,* and which was taken at Talewadi, Castle Rock, Kanara (a locality far removed from that wherein the type of *gravelyi* was found), is really the female of *P. mortoni.* Type in the British Museum.

Protosticta hearseyi Fraser.

Protosticta hearseyi Fras. Rec. Ind. Mus. vol. xxiv, pp. 5 and 6, Pl. 1, figs. 3 and 4 (1922); Id. ibid. vol. xxvi, p. 499 (1924).

Male. Abdomen 30-35 mm. Hindwing 18-21 mm.

Head,—labium ashy white; labrum turquoise blue narrowly bordered with black along the free margin; the two basal joints of antennæ blue; clypeus turquoise blue; frons, vertex and occiput black; eyes olivaceous above, paling and changing to pale blue beneath.

Prothorax pale blue, immaculate (Fading to pale brown in the dry state.)

Thorax cupreous on the dorsum, pale blue laterally, the middorsal carina finely blue, whilst laterally a broad oblique black stripe traverses the length of the postero-lateral suture and anterior part of metepimeron. Beneath whitish marked with a round spot of black between the legs and a pair of short stripes which converge and become nearly confluent with the anterior spot.

Legs bluish white, the two hind femora with narrow blackish transverse lines on the extensor surface; the knees black.

Wings hyaline, pterostigma black, shaped similarly to the rest of the genus, covering one cell; 10-14 postnodal nervures to forewings, 10-12 in the hind; *R4 + 5* arising opposite or distad the oblique nervure descending from the subnode.

Abdomen enfumed brown or cupreous marked with pale blue, this colour more in evidence on the final segments. Segments 1 and 2 with the sides bluish white and with a diffuse longitudinal stripe on the middorsum, incomplete on the apical half of 2; segments 3 to 7 with narrow pale basal annules extending more broadly along the sides and with broad black apical annules; segment 8 turquoise blue with a narrow black apical annule; 9 and 10 black, the former with a bluish crescentic spot on each side. Segment 7 twice the length of segment 8, 8 half as long again as 9 which is more than twice the length of 10.

Anal appendages black (Pl. figs. 1 and 2) about twice the length of segment 10, forcipate, chelate, broad at the base and furnished here with a robust inwardly directed sub-basal spine, then constricted and sub-cylindrical but again slightly expanded at the apical third to form a ' finger-and-thumb ' process, the finger portion considerably longer than the thumb and squared at its apex ; the whole appendage curving gently in and downwards. Inferior appendages about four-fifths the length of superiors, truncate, broad at base and tapering to a slightly and gently upturned point, the base furnished with a blunt inner tooth and one or two minute teeth thereafter.

Female. Abdomen 32-33 mm. Hindwing 22 mm.

Very similar to the male and approximately of the same length although more robust in build. Differs as follows,—labrum more broadly bordered with black ; eyes olivaceous brown above changing to pale green below ; middorsal carina of thorax obscurely white at its upper part only. Wings with 12-13 postnodal nervures to forewings, 12 in the hind ; *R4 + 5* arising at or but slightly distad of the subnode. Segment 7 with a broader basal annule, segment 8 brownish black marked only with a basolateral dirty white quadrate spot, segment 9 paler brown, marked with a broad white spot on each side confluent with a smaller subdorsal spot of the same colour.

Anal appendages black, very small, about equal in length to segment 10, conical, pointed. Vulvar scale robust, extending beyond end of abdomen.

Distribution.—Nilgiri Hills and Annaimallais. The type was taken at a small brook running through a coffee tote on the Gudalur Ghat, in June ; out of 17 specimens, only **one** was a male. A single male was taken later in the neighbouring Ochterlony valley. Recently I found the species in the Mudis, Annaimallai Hills, 3,000 ft. in May, where about 18 males but no females were taken. The locality was a rocky hillside in virgin jungle where a seepage not amounting to a brook found its way down through fern and moss to the river below, and the whole of the specimens were found in an area not covering more than a quarter of an acre ; search in neighbouring jungle revealed none. These specimens were in company with *Heliogomphus promelas* which were equally restricted to the spot. Returning a few days later *via* the Nilgiris, I again found *P. hearseyi* in the same spot on the Gudalur Ghat and by a curious coincidence took a number of females and only one male. This curious incidence of the sexes is very difficult to explain. The small size of the species and its cupreous colouring will serve to identify it from all others of the genus. It is the only species in which the two sexes are approximately of the same length.

Protosticta himalaica Laidlaw.

Protosticta himalaica Laid. Rec. Ind. Mus. vol. xiii, pp. 342, 343 (1917).
Protosticta lindgreni Fras. *Journ. Bom. Nat. Hist. Soc.*, vol. xxix, p. 741 (1923) ; Id. Ibid., vol. xxvii, p. 150, (1920).

Male. Abdomen 40-43 mm. Hindwing 25-26 mm.

Head,—labium pale brown or brownish yellow ; labrum turquoise blue narrowly bordered with black along its free margin ; clypeus turquoise blue ; frons, vertex and occiput steely bronzed black ; eyes black above changing to dark olivaceous and finally pale bluish green beneath.

Prothorax black on dorsum and upper part of sides, marked with a broad subdorsal longitudinal creamy yellow stripe on each side extending from the posterior lobe to the anterior end, yellow low down on the sides.

Thorax bronzed black on dorsum, pale blue at the sides which are marked with a moderately broad black oblique stripe extending along the posterolateral suture. Pale blue beneath unmarked with black. Legs pale sandy yellow, extensor surfaces of all femora black.

Wings hyaline, pterostigma dark reddish brown, almost black with a fine frame of light yellow bordering the enclosing nervures within, about one-third longer than broad, costal side only slightly longer than the posterior and the outer side but slightly longer than the inner ; *R4 + 5* in the forewings arising very slightly distad the oblique nervure descending from the subnode but opposite that nervure in the hind ; 14–16 postnodal nervures in forewings, 13–15 in the hind.

Abdomen blackish brown marked with white and pale blue as follows,—segment 1 bluish at the sides and with a white apical ring, 2 bluish laterally and marked on the dorsum with a bluish longitudinal stripe not extending to the apical border, segment 3 with a small white dorsal basal triangle and a broad apical black annule, segments 4 to 7 with narrow white basal annules, 4 to 6 with broad black apical annules, segment 7 with its apical half, the whole of 8 and 9 pale blue, segment 10 blue at its extreme base, black apicad. Segments 7 to 10 gradually decreasing in length towards the last segment.

Anal appendages about twice the length of segment 10, dark brown (Pl. figs. 11 and 12) ; superiors broad at base, compressed, with an angulation on the inner side near the middle not amounting to a spine, after which the appendages are curved downward and abruptly broadened into a scoop-like expansion hollowed out on the inner side. Inferiors slightly longer than the superiors, broad at base, then constricted and again broadened and with the edges strongly curled like a drying leaf. A long inwardly directed narrow spine springing from the upper side of this expansion about the middle of appendage.

Female. Abdomen 37 mm. Hindwing 26 mm.

Very similar to the male, differs only in its shorter and more robust abdomen and in some of the markings of this structure. The venro-lateral aspect of segment 3 as well as 1 and 2 are definitely blue, segments 4 to 6 have broader basal annules especially the latter segment, 8 has a large blue spot on each side, whilst 9 and 10 are reddish brown. (Possibly blue in the living state.) Anal appendages small, rather shorter than segment 10, conical, pointed, blackish brown. Vulvar scale robust, extending a little beyond the end of abdomen.

Distribution.—Northern Bengal, Assam and Sikkim at altitudes of 3,000 to 6,000 ft. I have examined specimens from Kalimpong and Pashok and have taken the insect at Moungpoo, Darjeeling district in May and June. Although so widely spread, it does not appear to be nearly as common as some of the South Indian species. Its habits are entirely similar and it is found in similar localities. Abdominal markings and the shape of the anal appendages which are entirely different to the genotype will serve easily to distinguish it from all others. A fresh comparison of the types of *himalaica* and *lindgreni* has convinced me that they are conspecific, the former name having priority.

Protosticta uncatus, sp. nov.

Male. Abdomen 42 mm. Hindwing 21 mm.

Head,—labium pale brown ; labrum turquoise blue narrowly bordered with black along the free margin ; anteclypeus turquoise blue ; postclypeus, frons, vertex and occiput bronzed black ; eyes dark olivaceous green, paler below.

Prothorax pale yellow marked with a pair of ill-defined, longitudinal, subdorsal dark brown stripes made up of a row of three spots, the largest of which is situated on the posterior lobe.

Thorax bronzed black on dorsum, pale blue laterally changing to pale yellow beneath, which is unmarked. A narrow oblique black stripe on each side mapping out the postero-lateral suture, and a small upper posthumeral blue spot.

Legs pale yellow, knees darker, hind femora with a black stripe along the extensor surface.

Wings hyaline ; pterostigma as broad as long, costal side only slightly longer than posterior, the inner side very oblique, blackish brown framed in black nervures which are lined inwardly with pale yellow ; 15–16 postnodal nervures to forewings, 15 in the hind ; *R4 + 5* well distad of the oblique nervure descending from the subnode.

Abdomen shaded with brown and ringed with blue, white and black as follows,—segment 1 with the sides blue dorsum blackish brown, 2 with the apical half blackish brown, basal half on dorsum warm brown, the sides blue for the basal three-fourths but this colour invaded by the brown of dorsum at its middle, segments 3 to 6 with broad basal pale bluish white annules and equally broad apical black annules, the intervening part warm brown, 7 with only the basal annule, the rest brown gradually deepening to black at apex, 8 black with a small baso-lateral spot on each side, 9 entirely turquoise blue, 10 entirely black. Segment 7 three times as long as 8, which is half as long again as 9, the latter nearly four times as long as 10.

Anal appendages black ; superiors as long as segment 10, broad at base, then tapering as far as their middle at which point they are bent down rather abruptly and terminate in an expansion shaped like a parrot's beak. Inferior appendages slightly longer, broad at base, spatulate, compressed and furnished at the apex with a tuft of about 10 to 12 stout bristles.

Female. Abdomen 35 mm. Hindwing 21 mm.

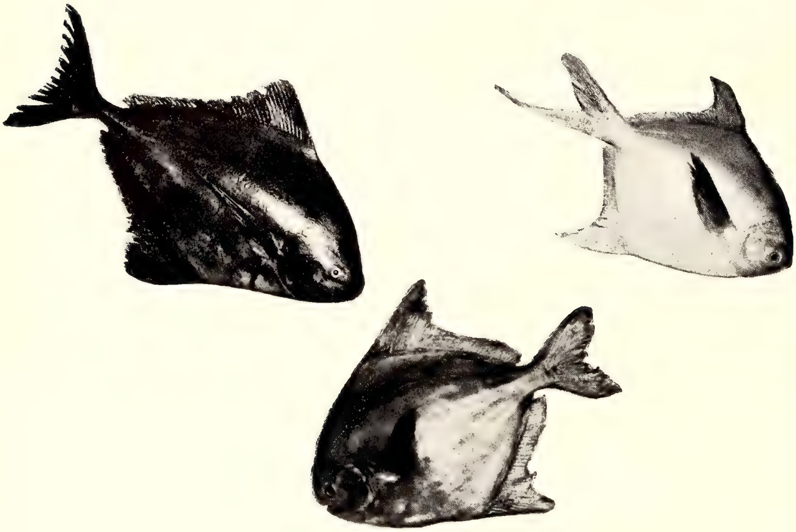
Closely similar to the male save for its sexual characters and the slightly shorter and more robust abdomen. Markings of head, thorax and abdomen not differing markedly from the male but segment 9 has a narrow basal black annule and the sides low down dark brown. Wings similar, 15 to 16 postnodal nervures in forewings, 15 in the hind.

Anal appendages very short, not quite as long as segment 10, conical, pointed, blackish brown. Vulvar scale robust, extending beyond end of abdomen.

Distribution.—Maymyo and Gokteik, South Shan States. One male and two females collected by Col. F. Wall, I.M.S., during the early part of June. The species is remarkable for its anal appendages, which like those of *P. himalaica* differ markedly from those of the genotype. The situation of the 'recognition' mark on segment 9 instead of 8 is also quite at variance with other species of the genus. These specimens were taken at light but should the habitat of the insect be discovered, it will probably prove to be similar to that of other species and the species itself equally common.

(*To be continued.*)

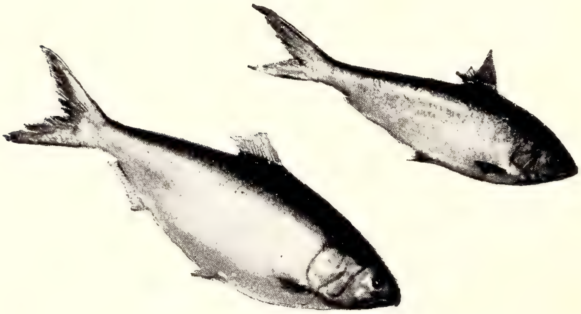
BOMBAY FOOD FISHES.



POMFRETS.

Black Pomfret (*S. niger*). Silver Pomfret (*S. cinereus*).
White Pomfret (*S. sinensis*).

SARDINES.



Pala (*Clupea ilisha*).

THE FISH SUPPLY OF THE WEST COAST OF INDIA.

BY

SIR REGINALD SPENCE, KT., M.L.C., F.Z.S. AND S. H. PRATER, M.L.C., C.M.Z.S.

PART II

(*With five plates*).

(*Continued from page 991 of Vol. XXXIV.*)

ESTUARY AND 'INSHORE' FISHING.

There are various other fishes commonly obtained in our creeks and estuaries on the sustained supply of which the Industry, not to say the consumer, is actually dependent. Our coastal waters hold a number of resident and migratory fish which are of economic value. Among the larger resident species are the Grey Rock Perch (*Chrysophrys datnia*) known locally as the *Kharwad*, a Cat-Fish (*Arius falcarius*), Grey Mullets (*Mugil œur, beorneensis, waigiensis* and *dussumieri*). *M. waigiensis* is abundant in the creeks during the rainy season. *M. poicilus* is abundant during the cold weather. All of these are excellent table-fish. They visit quiet bays and also our docks and wet basins where they are fished for by men and boys from the dock-walls. The larger Mullet (*M. poicilus, M. œur* and *M. waigiensis*) known as *Boi* or *Pilsa* range from 3 lbs. to 100 lbs. in weight, their retail price varies from As. 12 to Rs. 1–4 each or As. 4 to As. 6 per lb. The season is July to November.

The Lady Fish (*Sillago sihana*) known locally as *Murdi* is common in our creeks. Its flesh is recommended to ladies just in or just out of an 'interesting condition'! Small perch-like fish (*Therapon*) are also abundant. They live easily in fresh water and are often placed in wells. *Therapon jarbua* is very common. It is known locally as the *Khargota*. Other species seen in the Bombay market are *T. quadrilineatus* and *T. theraps*. Gobies occur in numbers. Amongst these *Gobius ocellatus*, the *Kharba*, is the commonest. Other species from the Society's collection taken in the Bombay market are *Gobius macrostoma, viridipunctatus, masoni, striatus, ornatus* and *giurus*. Besides these resident species, there are a number of migratory forms which visit the creeks and estuaries in the season. In June, July and August the Cock-up (*Lates calcarifer*), known locally as the *Kajura*, is taken at the entrance of creeks which they enter with the rising tide. They come up the creeks in search of their favourite food, the Niwtas (*Boleopthalmus* and *Periopthalmus*), which live in thousands on the mud banks where their slippery movements can be watched when the tide has receded. Many species of estuary fish come up the creeks not only for food but also for spawning, the main season for which is during the monsoon. Sea-fishing is then at its lowest and the energies of the fishermen are concentrated upon these fishes to the great destruction of enormous numbers of fry.

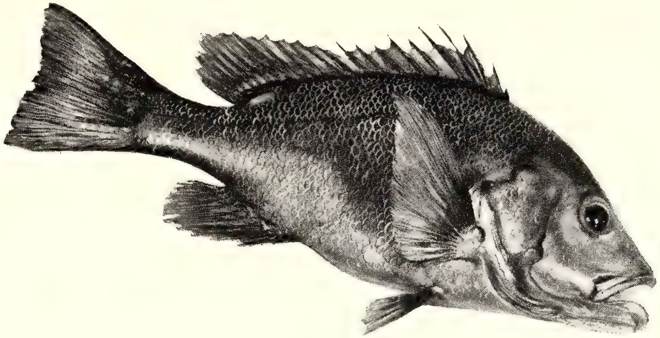
Among the larger migratory fish are three species of Bhamin, *Polynemus tetradactylus*, known, according to Wallinger, to the Kolaba fishermen as the *Chola* (young) and the *Dara* (adult), *Polynemus plebius*, known as the *Rawas* and *P. heptadactylus* known as the *Shendwa*, and a large *Sciæna*, the *Gholmasa* (*Sciæna sina*). Examples of this fish quite 6 feet in length are brought to the Bombay market.

The numerous creeks and inlets of the upper waters of Bombay harbour and of the Konkan coast line are a particularly good haunt for the various species of *Polynemus*. The creeks are full of shrimps and prawns and the fry of several sorts of estuary fish from which these voracious monsters take heavy toll. Bhamin (*P. tetradactylus*) and Rawas (*P. plebius*) work up the creeks in shoals with the rising tide and rush back to sea as it recedes. In the smaller creeks they are netted at high tide ; in the more open water of the harbour at ebb. In Bombay the best months are June, July, August and September; the worse the weather, the better the day. In the creeks, Rawas and Bhamin are caught in drift or tramel nets called *Jal*. A large *Jal* is about 165 feet in length by 10 feet in depth. The top of the net has floats hung 5 feet apart, the bottom is weighted. The weights vary according to the nature of the fish which is intended to be caught —for *Lates calcarifer* (Cock-up), which are ground-feeders, the net is heavily weighted so that the bottom touches the ground—for *Rawas* less weight is used so that the net makes a floating wall near to the surface. When used with a boat, the *Jal* acts as a drift net but in creeks the two ends of the net are anchored. 'Bhamin' and *Rawas* when ascending a creek to spawn, take a more or less definite path. It is not at the deepest part nor is it the shortest way across. The path taken by the fish are known to fishermen who set their nets accordingly.

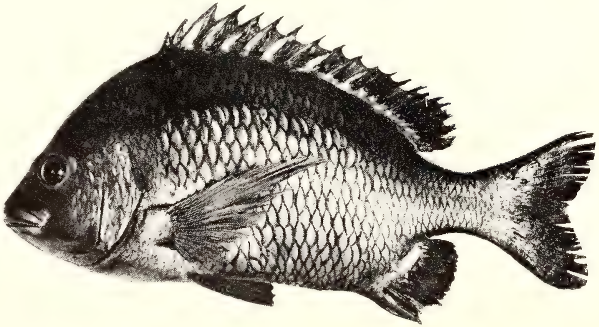
Other species taken in the creeks are *Lutianus johnii* (Tamb) and a horse-mackerel (*Caranx nigripennis*). Gar fish are abundant in season, the commonest species is *Bellone strongylurus* (Toli, Tolka and Tol). Gar fish are long pike-like fish with tapering, well-armed jaws. They are surface feeders lying almost stationary about piles of rocks or by the walls of piers in a good tideway and flashing out at passing prey. The Cat-fishes are represented by *Plotosus canius* (Kalamb), the Crocodile fish by *Platycephalus scaber* (Shatira). Other species which visit the creeks and estuaries in numbers are *Trachynotus russelli* (Nalbi and Dangul) one of the *Carangidæ*. A sole (*Pseudorhombus javanicus*) known as the Rhepta or Shivra and the Warra (*Scattophagus argus*) which is as flat as a pomfret and heavily marked with black blotches. The smaller migratory forms which are taken in large numbers along the coast are Anchovies (*Engraulis taty* and *mystax*), known as Palkati and Taikati. Ribbon fish (*Trichiurus savala*) to which we have already referred ; they are known locally as Wakti. Silver-Bellies, mainly *Gerres lucidus* (Muigan), *Equula brevirostris* (Surgutta) which grow to a foot in

BOMBAY FOOD FISHES.

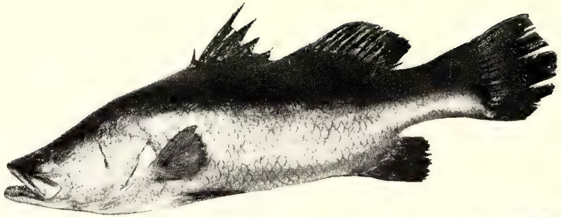
PERCHES.

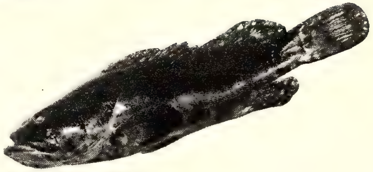


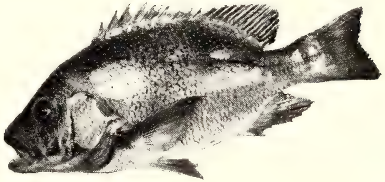
Rosy Perch (*Tamb*) : *Lutianus argentimaculatus*.



Black Sea Bream (*Palu*) : *Chrysophrys berda*.







Cock-Up (*Kajura*) : *Lates calcarifer*.

Rock-Perch (*Vekru*) : *Serranus sp*.

Speckled Perch (*Lutianus rivulatus*).

length, and Sardines (*Clupea lile*). Prawns and crabs are taken in enormous numbers.

As stated previously no statistics of the quantities or the value of the various species of fishes sold along the Bombay coast are available. The Fishery Department of the Madras Government has set an example to the rest of India as to what can be achieved in the way of obtaining information about the quantities in which the various marketable fishes are obtained and the economic value of these species. We know nothing of the annual yield of the Bombay Fisheries and we know still less about the life histories of the food fishes of our coastal waters. These are subjects which present an enormously interesting and profitable field of enquiry and subjects which come definitely within the province of a Department of Fisheries which unfortunately does not exist in Bombay.

FISHING GROUNDS

As regards Fishing Grounds we learn from the Report that 'the Gulf of Kutch gave the highest catch per hour of all fish together (145 lbs.) and the conclusion may be drawn that this area, at least in the season when the samples were taken, holds a good stock of trawl-fish. But the position of undesirable snags in the form of coral reefs requires investigation to ensure against the possibility of the losses outweighing the gains.'

'All the grounds except the inadequately sampled Southern Grounds and the Gulf of Cambay (off Daman) show a catch per hour of over 100 lbs. The general mean may be taken as not less than 1 cwt. of fish per hour, as it should be borne in mind that the data from which the figures are calculated are the weights of the several sorts of fish as observed at sea which were in general below, and in some cases considerably below, the actual weight of the total fish caught.'

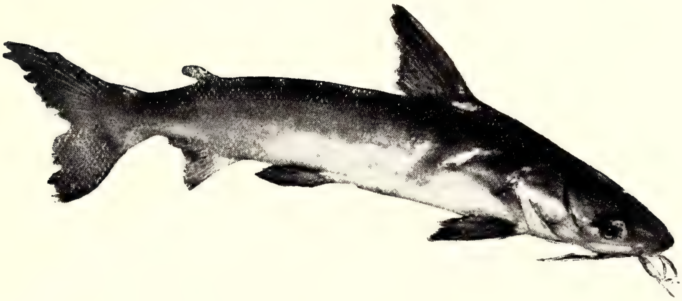
'The Southern Grounds make a poor showing. Our work here was very limited, and it is likely that the figures are in deficit of average conditions, for we know from the coastal fishings that fish are to be found in abundance on these coasts at certain times of the year. The probability is that they move in shoals and shift their grounds suddenly. Further trawling trails might throw sufficient light on their movements to enable one to pursue the fishing with successful results.'

'Considering the more important individual species, the Sind and Gulf of Kutch grounds give the highest figures for Goal. The Kathiawar Grounds and the Gulf of Kutch show the best average yield of Pomfret. The West Coast of Kathiawar, Gulf of Kutch and Sind Grounds show a marked predominance of "Karel" and there seems no doubt but that this species has its maximum density of distribution to the northward. "Wam" are clearly most abundant on the muddy grounds adjacent to Bombay, while "Shingala" are shown to be in general distribution though the highest rate of catch is given by the four hauls in the Gulf of Kutch. *Rays* (wagli) appear to be most abundant on the Bombay Grounds and off South Kathiawar and are conspicuously less in evidence on the cleaner grounds off Sind where also the *Wam*, which is a characteristic inhabitant of muddy grounds, is similarly lacking. The shark-like species are shown in greatest abundance off Kathiawar (West) and Kutch.'

The tables published in the Report point out, Mr. Hefford writes, ' the distinct drop in the quantities of fish caught when the 30 fathoms line is crossed, except in the case of the post-monsoon fishing when the catch of " goal " slightly exceeded and the catch of pomfret and wam in the 30–40 fathom zone—the average depth was however only 33 fathoms—approximately doubled the normal. It may be noted however that these catches were derived from only 10 hauls which are almost all made near the northern limits of the Bombay Grounds. There are not sufficient data for this locality in other seasons for comparison to enable one to judge whether this is a purely seasonal feature or not. There are indications, however, that as one leaves the latitude of Bombay and proceeds towards the Kathiawar coast, there is a tendency for the fish to be found extending further seaward than is the case further south. How far this is connected with the effect of the large rivers Narbudda and Tapti or whether it has to do with the strongly moving tides of the Gulf of Cambay, are interesting questions which need not be further pursued here. All that can be concluded from the data we have been able to gather, is that in general the heaviest catches of fish made by the trawler were made in the neighbourhood of the 20 fathoms line. Occasionally, unusually good catches were made near or below 10 fathoms on the one hand and in the neighbourhood of 30 fathoms on the other hand. But for all-round fishing the middle depth of 20 fathoms seems preferable. It may be mentioned too that near this contour the grounds appear to be most free from obstructions liable to cause damage to the trawl. Near 10 fathoms there is more liability to meet with rocks, wreckage or such snags as old fishing-stakes, and moreover foul hauls, through the otter-boards overriding the wings of the trawl in shooting, are especially liable to occur in shallow water. Beyond 30 fathoms depth the risk of encountering coral is considerably increased.'

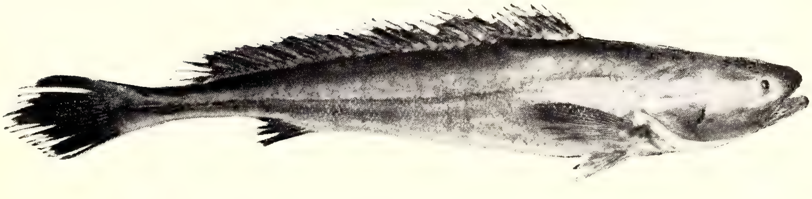
Mr. Hefford's conclusions are that in the case of ' Goal ' it would appear their maximum density of distribution lies inside the 20 fathoms line, though at the end of December they were found in abundance up to 36 fathoms about 60 miles NW½W from Kundari. In that same neighbourhood and at about the same time pomfrets also appeared in more than normal abundance, in contrast with their tendency during the Pre-monsoon and monsoon seasons to show in greater abundance on the landward side of the 20th fathoms line. The results indicate for ' Karel ' an off-shore tendency during the Pre-monsoon months and an in-shore concentration in the monsoon and after. ' Ravas ' are clearly revealed as shore-hugging fish except in the post-monsoon when *Polynemus indicus* no less than 'Goal' and pomfret were found in the northern half of the stretch between Bombay and Diu to be distributed in depths which were greater than those which afford their normal habitat elsewhere. The same applies to ' Wam ' which, however, show a very distinct aggregation in the vicinity of the 20 fathom line—

BOMBAY FOOD FISHES.



Cat-Fish (*Singhala*) : *Arius dussumieri.*

Bombay Duck (*Bombil*) : *Harpodon nehereus.*



Indian Haddock (*Dori*) : *Sciænoides brunneus.*

more above than below that depth—in the pre-monsoon month of February. The maximum figure for 'Shingala' is shown for the 20–30 fathom zone in the monsoon season. In other seasons they appear to be more abundant at less than 20 fathoms depth.

'The data from the distant Sind grounds are comparatively scanty and practically limited to the months of December, January and February, but so far as they go they indicate for "Goal" an in-shore concentration in the pre-monsoon month of February. In April and May, one knows from the big local fishery that then takes place, there is a remarkable immigration of "Goal" to the coast in the neighbourhood of Karachi. The figures for "Karel" also appear to indicate a moment to the shallower waters in February.'

'It is a noteworthy fact, though based on only 3 hauls, the average depth of which was 32 fathoms, that the highest catch per hour figures are shown for the 30 to 40 fathom zone in the post-monsoon fishing. The predominant species are goal, pomfret and karel. A comparison is suggested with the similar conditions noted above for the northern Bombay grounds. In each case it seems probable that the neighbourhood of large rivers tends to push out the seaward limits of fish distribution.'

'The data from the South Kathiawar grounds are perhaps too scanty to allow of any very precise conclusions as to variations in bathymetrical or seasonal distribution. It is significant, however, that fairly good catches are shown here for the deeper zones just as was shown by the hauls made in the adjacent grounds of the Bombay area to which reference has been made above. Probably no significance can be attached to the figures for the separate species for comparative purposes, but the indication of a post-monsoon concentration towards shallower water in the case of goal and the relatively high catches of pomfret in the deeper zones at this season may be noted, as well as the increased "Shingala" catches from the 10–20 fathoms zone in the post-monsoon data (derived from the January hauls).'

'The haul which yielded the highest catch per hour of all (of 801 lbs. per hour) was Haul No. 90, the first haul of voyage xi, made on August 19, 1921, at a depth of 15 to 16 fathoms 9 miles west by north from Kundari (Kenri) Island. It is of interest to note the very close proximity of this spot to Bombay. The catch per hour of the different sorts of fish taken in that haul was as follows (expressed in lbs. to the nearest decimal figure):—

Goal	384·0	lbs.	per	hour
Karel	213·8	,,	,,	,,
Dori	101·3	,,	,,	,,
Rays	42·6	,,	,,	,,
Wam	24·0	,,	,,	,,
Sharks	13·3	,,	,,	,,
Shingala	6·6	,,	,,	,,
Ravas	4·8	,,	,,	,,
Palu	4·8	,,	,,	,,
Tambusa	2·1	,,	,,	,,
Pomfret	1·3	,,	,,	,,
Chand	0·8	,,	,,	,,

'Considering individual sorts of fish, the best catch per hour of Goal was 280 lbs. in Haul No. 250 (Voyage xxv, Haul 6) made on the Sind grounds on December 6, 1921, on the northern edge of the Swatch, shooting in more than 50 fathoms and hauling in 17 fathoms at a distance of 52 miles SSE from Cape Monze. The elusive movements or the local concentration of the off-shore shoals of goal—a condition which is well described by the trawler-man's terms "Spotty"—is exemplified by the fact that a second haul, for which the trawl was towed as nearly as possible over the same ground, produced not a single Goal. The haul which produced the second highest catch per hour (209 lbs.) of Goal was also made on the Sind ground, viz., Haul 376 which has been referred to above as yielding the highest total catch of this species. It should be noted that the depth here was 13 to 14 fathoms only. The third highest catch per hour of Goal was 142·9 lbs. made on February 26, 1922, sixty-seven miles SE½S from Diu Head (or about 100 miles roughly NW from Bombay) in 20 fathoms. Four other hauls made on the Bombay grounds yielded a catch per hour of over 100 lbs. of Goal. The catch-per-hour figures were 141, 114, 103 and 124 lbs. and the depths 16–15, 15–19, 21–17 and 22 fathoms respectively. The practical conclusion to be drawn from these data is that the best catches of Goal are generally to be made inside the 20 fathoms line.'

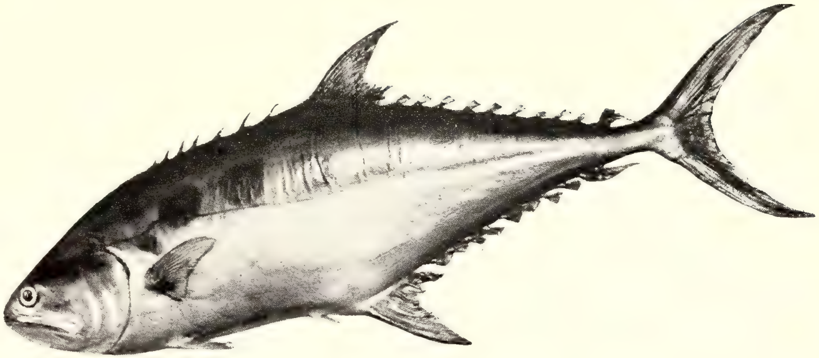
'With regard to the catches of Pomfret, only 10 hauls show catch-per-hour figures which exceed 20 lbs. Two of the above hauls were made on the South Kathiawar grounds and one in close proximity to this region. One was made on the Sind grounds in comparatively shallow water (16–15 fathoms). The optimum depth for the Bombay grounds appears to be a little below 25 fathoms though some good catches were made from tows which were taken at greater depths. Where the depths at the beginning and ending of the tow vary so much as from 24 or 27 fathoms to 40 fathoms, it is of course impossible to say from what of the line the fish were most derived and such hauls are, therefore, of little value as survey data.'

'The voyages which yielded the best catches of Pomfret were Voyage xviii made in October on the grounds abreast of Bombay Harbour, with an average catch-per-hour for the whole fishing time of 20 lbs. of pomfret, Voyage xxii made in November to the grounds in the vicinity of Diu Head (114 to 130 miles NW½W from the Prongs Light covering the best of the fishing) with a catch-per-hour of 12 lbs. of pomfret, and Voyage xxxiii made in February on the Bombay grounds when the best catches were made in the area lying between 20 and 25 miles roughly NW by W from Kundari (catch-per-hour of pomfret for whole voyage, 15 lbs.).'

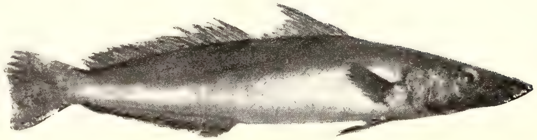
'Regarding the catches of Karel, to sum up the indications as concisely at the data will allow, it may be said that the best average catches were made on the Sind grounds, where the depths above 20 fathoms showed a greater abundance of these fish in the month of December and January, whereas in February the more shallow water inside the 20 fathom gave the better results. On the Bombay grounds there are indications of a concentration of the species for

BOMBAY FOOD FISHES.

HORSE MACKEREL.

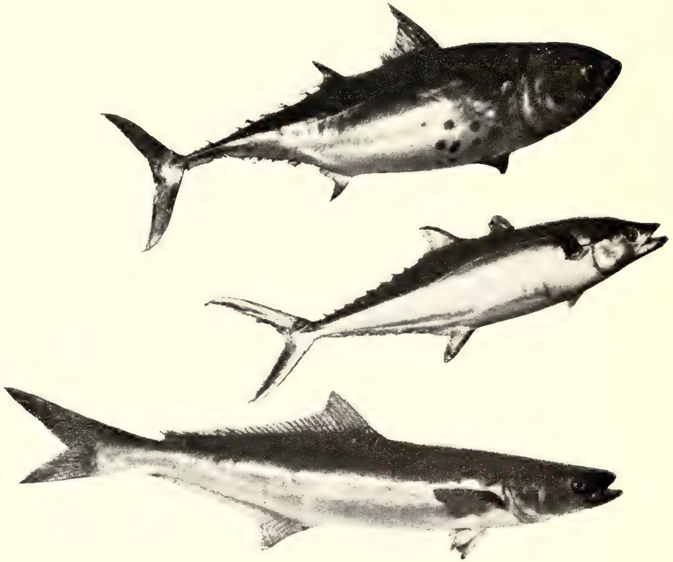


Falai (*Chorinemus toloo*).



Lady Fish (*Murdi*) : *Sillago sihana.*

MACKERELS.



Tunny (*Cuppa*) : *Thynus thunina.*

Seer (*Surmai*) : *Cybium khulii.*

Sakala (*Elacate nigra.*)

the monsoon months which seems to be associated with the incidence of spawning.'

CONCLUSION

In 1918 when it was decided to acquire a Steam Trawler to investigate the unknown fishery resources of our local waters, it was resolved at the same time to secure the services of a Marine Biologist to investigate the resources to be exploited. Subsequently a change in the policy required the Marine Biologist to subordinate exploratory work to a new objective—that of catching and landing fish for the Bombay market. The experiment of placing trawl-caught fish on the Bombay market was doubtless an interesting one, but it is obvious that making marketing a primary condition was a handicap to exploratory work at sea. Putting exploitation before exploration was exactly putting the cart before the horse.

The operations of the trawler were not a commercial success ; as, at no time did the proceeds from the sales of fish approach anywhere near working expenses. The working expenses averaged Rs. 11,175 per mensem, the monthly receipts from the sales of fish averaged Rs. 2,205. 33 per cent of the working expenses represent wages and 29 per cent coal consumption. Mr. Hefford points out that the pay of the European crew was fixed at a time when the trawling industry was booming in England and wages were at a very high level. The same is to be said about the initial outlay. A Trawler like the *William Carrick* which cost £17,000 in 1920 could have been bought for £7,000 in 1923. Again, expenditure was greatly increased by lengthy, unproductive periods which the trawler spent at sea or in docks. Thus the monthly receipts from the sales of fish caught by the *William Carrick* cannot be taken as a true indication of the commercial possibilities of trawling in our coastal waters. The rate at which fish were caught both in the average and in special seasons is a better guide. The average catch per hour throughout the period of operations works out at 116 lbs. which in Mr. Hefford's opinion could not only be equalled but exceeded by a properly established commercial concern. A commercial fishing trawler could put in at least 20 fishing days a month. The *William Carrick* only approximated this in three out of the 9½ months she was at sea. She landed her catches four times a month, whereas a commercial trawler, as Mr. Hefford indicates, could make as many as ten landings bringing in supplies every third day. Daily landings, although they involve the maintenance of a fleet of 3 or 4 vessels, would provide a yet better chance of commercial success. Mr. Hefford believes that 20 tons of fish is not an excessive estimate of the possible catch of a trawler operating in local waters and he believes that it is safe to assume that a commercial organization would be in a position to obtain 300 per cent better prices than the *William Carrick* could command. He writes: ' The real competition would be not with the local fishermen but with the merchants and vendors in the Bombay markets. A power fishery concern cannot carry on modern methods of production if it is left to the mercy of the fish merchants at Crawford market to fix the prices it will get for its fish. It must be in a position, at least with a considerable proportion of its supplies, to side-track the middle man and supply direct to the consumer. To do this it must be in a position to guarantee regular supplies. This is most important and this is where a firm working three or four vessels, would have a better chance than a single boat concern.' A smaller trawler than the *William Carrick* would diminish working expenses and coal consumption. Two alternative types are suggested :—a steam drifter equipped with a trawl, Danish seine and drift-nets, or a fleet of fast motor-propelled cutters equipped with seine-nets, etc. So far as Bombay is concerned, Mr. Hefford is of opinion that the type of vessel which would pay best, could only be ascertained after practical demonstration.

The publication of the details of the work carried out by the *William Carrick* are of great practical value as they demonstrate the possibilities of commercial trawling in Bombay waters and provide data as regards the more important economic fishes. It is clear however that a fishery survey of the seas of a Presidency with over 1,000 miles of coast line cannot have been carried out very far over a short period of 9 months.

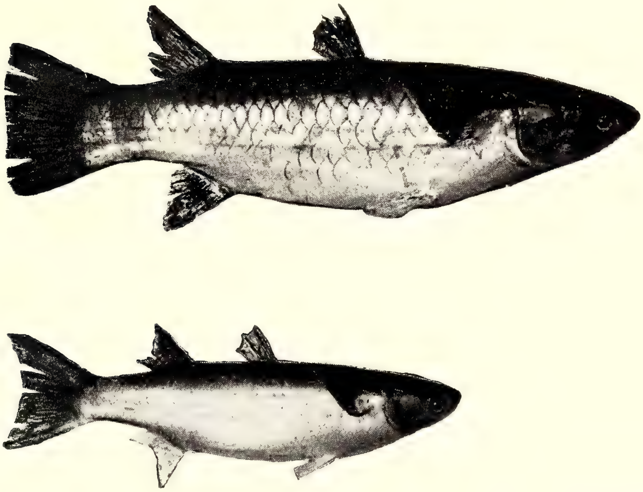
The present prospects of the continuance of fishery investigations are somewhat blank. The posts of Marine Biologist and Assistant Marine Biologist have been abolished. The inconclusive ending of a costly enterprise emphasizes the fact that experiments in this field are fore-doomed to failure unless supported by the practical commercial marketing of fish on the one hand and by scientific investigation on the other. The direction should combine knowledge of local fishing conditions from both the practical and the scientific standpoints.

Power-fishing—not necessarily Steam-Trawling—will some day become one of the great industries of the Bombay Presidency and the present set-back is we believe purely of a temporary nature due to faults in the conception and carrying out of previous schemes.

It is evident that wide local knowledge of the life history and habits of our food fishes is essential to secure success. We must know, at least, the salient facts about our fishes, their breeding seasons, spawning grounds and the main factors controlling their periodic migrations that are the outstanding characteristics of most of our valuable marketable fishes. Knowledge of this description will assuredly enable our sea-fishing industry to develop on modern lines, and so obtain the largest possible quantities of fish in the best condition upon an expenditure low enough to permit of sale at reasonable prices. Successful marketing in Bombay implies low working costs or, in the alternative, greatly increased supplies. Perhaps in no other industry depending directly on the spontaneous produce of Nature, can the possible results so amply repay the capital and labour expended upon it. But the practical Zoologist is essential to success and it is also needful that any extensive steam or motor fishery should have strong and patient financial backing and should be run in conjunction with a well-thought-out and extensive cold storage and distributing agency. It is probably

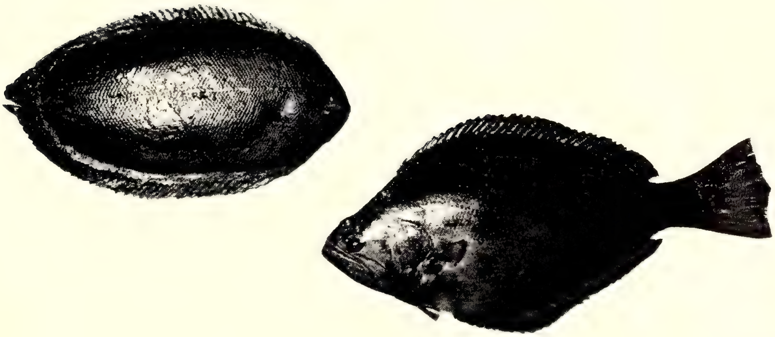
BOMBAY FOOD FISHES.

INDIAN MULLETS.



Hilsa (*Mugil dussumieri.*)
Boi (*Mugil oeur.*)

FLAT FISHES.



Sole (*Synaptura cinerascens.*)

Indian Halibut (*Bakhas*) : *Psettodes erumei.*

easier to catch fish than to dispose of them at remunerative rates. This is not work for a Government Department. Government should confine itself to the investigations needful to supply data essential to commercial success. It is not part of their province to try directly and through their own organization to develop commercially such capitalistic methods of fishing as Steam-trawling. The Steam trawler *Lady Goschen* operated by the Madras Fishery Department is at present engaged purely in investigation and survey. She is not worked with the idea of catching large quantities of fish or landing them at quick intervals and at suitable places for the market. In short, the Madras Fishery Department are not competitors of the fishermen; they are working to obtain information which will put the fishing industry on a better basis.

Extensive cruises along the Malabar Coast have enabled Capt. Cribb, the Skipper of the trawler *Lady Goschen* to obtain a general idea of the South-West Coast, a detailed survey of which is now being undertaken.

An important point emerging from this survey was the discovery that a region extending from the 15 to the 55-fathom line opposite Calicut abounded during November and December with the young of many varieties of food fishes. The area constituted a vast nursery at this time of the year. Another discovery was that S. W. and N. W. of Calicut between 21 and 29 fathoms the sea bottom is subject to great change, apparently due to the depth of the mud and sand. Trawling in this area in November and December 1928 revealed the presence of a rocky bottom—while fishing in the same grounds in April 1929 showed the complete absence of rocks. It is suggested that the strong currents set up by the monsoon, sweep the sea bottom of mud and sand and leave the rocks exposed at the end of the monsoon. Changes of this nature must have a definite effect on the type of fish which inhabit the sea-bed at different seasons of the year. The investigations and explorations now being conducted by the Madras Fisheries Department are slowly building up a mosaic of knowledge which will pave the way to the greater development of the fisheries under its control.

The fish supply of Bombay City is at present much below its needs. The local fisheries are not able to supply the demand and our markets are largely dependent on imports from Karachi, Broach, Damaun and the Kathiawar Ports.

The local fishing population on the caste basis numbers about 10,000 out of which about 6,000 work in the trade or are actually employed on the boats. The local fleet roughly numbers 210 boats of varying capacities. The smallest are worked by two persons. They operate within a radius of 3 to 4 miles from the shore. The larger boats or ‘ Muchwas ’, manned by a crew of half a dozen, go further afield to places like Bassein and Palghar where there are probabilities of securing large catches. The local trade has suffered considerably during recent years from various causes. Firstly the profits of the Industry do not go to the fisherment but into the pockets of contractors and middlemen. Owing to the spread of education it has been suggested that there is a tendency among children of fishermen to give up the work of their forefathers and to seek their livelihood in Government service or elsewhere. Again, the increased cost of living in Bombay is reflected in the higher wages demanded by fishermen and by people engaged in the transport of fish to the market, in the increased cost of nets and fishing gear and the consequent increase in the price of fish ; factors which have caused many connected with the trade to migrate to ports where labour is cheaper and where, as an additional advantage, taxes such as are levied in Bombay have not to be paid.

There are 17 municipal markets and 17 private markets in Bombay most of which handle fish which is brought from bunders such as Back Bay, Chowpati, Colaba, Worli, Mazagaon and Dharavi. In addition, fish is imported from various ports along the coast by steamer and rail. Catches landed at the local bunders are carried on the heads of coolies in open baskets to the markets where they are exposed for sale in the stalls. Complaints have been received from the public regarding this method of transport in open baskets exposed to the attention of crows, but no action can be taken by the municipality to remedy the existing state of affairs as there is no provision in the Municipal Acts which would empower them to do so. Besides the fishermen point out that covered baskets would accelerate decomposition.

The introduction of refrigerating chambers for the cold storage of fish has enabled local merchants to import iced fish from coastal ports and to store it till it is wanted. Fish brought by steamers from coastal ports are packed in air-proof ice boxes or ordinary boxes and baskets. An insufficient supply of ice often leads to decomposition of fish so transported. The railways do not provide, at present, cold-storage trucks for the transport of fish.

Imported fish is brought to the markets for sale or storage. The Crawford market and the Erskine Road markets are the chief distributing centres from which the smaller markets in the city receive their supply. In addition to cold storage at Crawford market there are other refrigerating chambers started by private enterprise. Among these are the plants maintained by the City Ice Supply Co., the Bombay Ice Manufacturing Co. and Dhunjibhoy Pestonji's Ice Factory. The storage capacity in Crawford market is about 100 tons of fish, frozen solid, at a temperature running down to 10 degrees above zero. The fish merchants are now able to fill the cold stores with fish when it is plentiful and cheap and sell it retail when expensive and scarce. This, while it may benefit the fish merchants and vendors, is of doubtful value to the fishermen or the consumer but better organization and better facilities for cold storage have enabled the city's demand to be increasingly met from outside sources.

To summarize :—

(1) The present fish supply of Bombay City is not equal to the demand.

(2) The local trade cannot cope with the city's needs which are being increasingly met by imports from outside sources

made possible by the establishment of facilities for cold storage.

(3) The local industry has been adversely affected in recent years by increase in operating charges, due to higher cost of living in Bombay, taxes which have not to be paid at other ports and other economic causes which have influenced people connected with the trade to migrate to ports where working costs are less high.

(4) The possibility of increasing the local supply of fish has been demonstrated by the operations of the trawler *William Carrick.*

(5) The loss sustained by this vessel was due to faults in the conception and carrying out of the scheme.

(6) While a great disparity between working costs and the returns from the sales of fish obtained is evidenced in the operations of the *William Carrick*, the experience gained by its initial exploration of our coastal waters indicates that power-fishing, not necessarily steam-trawling, in local waters is commercially possible.

The factors which should ensure commercial success are—

(1) The reduction of working cost by the use of a smaller vessel with less coal consumption or as alternatives a steam-drifter equipped with a trawl, Danish seine-nets and drift-nets or :—

(2) Motor-propelled cutters with similar gear.

A larger number of working days at sea than was possible with the *William Carrick.* This would ensure for commercially controlled vessels a greater output.

(3) A fleet of 3 or 4 vessels which would enable daily landings of fish and thus guarantee regular supplies.

(4) Power-fishing to be successful under local conditions must be run in conjunction with a well-thought-out system of cold storage and an efficient distributing agency.

(5) Successful marketing of trawl-caught fish depends largely on the controlling concern being in a position to guarantee regular supplies for sale direct to the consumer without the intervention of middle-men.

Government co-operation is indicated in the investigation and the supply of data essential to commercial success.

A department of fisheries under the control of a Marine Biologist with practical experience of local conditions might with advantage provide statistics and information relative to :—

(*a*) The various species of marketable fishes obtainable on one coasts, the quantities in which they are obtained and the value realized.

(*b*) The ports at which various species are abundant at different seasons of the year and information as regards times of fishing and weight and values of fish obtained.

(*c*) The fishing grounds and the depth at which the more important economic fishes are taken at different ports at different seasons.

(*d*) The life histories, habits and periodic migrations of our more important economic fishes.

(*e*) The various types of nets used by local fishermen, the destruction of fry in creeks, rivers and estuaries by the use of particular types of nets or traps.

(*f*) Any conditions which are adversely affecting the local industry in Bombay,

and finally :—Suggest measures for the utilization and development of by-products of the industry.

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THE STUDY OF INDIAN BIRDS.

BY

HUGH WHISTLER, F.S.Z., M.B.O.U.

PART VII.

(Continued from page 735 of Vol. XXXIV)

THE REPRODUCTION OF BIRDS.

Preliminary Remarks.

This series of Articles started with an account of the origin of birds and then went on to discuss some of their most striking physical characteristics. Now I propose to treat of certain aspects of their biology, that is, the study of their lives.

One of the most dominant motives of life is reproduction. Throughout the whole gamut of Nature, we find that one of her chief pre-occupations, one of her chief incentives to action, is the handing on of the torch of life. The present is but a fleeting moment. The life of the individual is all too short, a speck in the universe of time. The present and the individual alone are nothing and without meaning. Their significance is only attained when invested with a past and a future, when they take their places in the unending chain of destiny. Hence, consciously and unconsciously, the individual life finds one of its chief activities in reproduction; growth and maturity lead up to the reproductive period. That great duty accomplished, life descends to the common grave.

In the study of birds, in particular, we find that the many-sided aspects of their reproduction evoke the greatest interest and produce the most striking facts.

The Dialectician has often delighted to debate on whether the hen or the egg came first. I propose to settle the question in a summary way and say that the first item in the reproductive cycle of birds is found under the heading of courtship, using the term somewhat widely to embrace a number of points which lead up to the production of the eggs from which emerge the young.

The first point to get clear in one's mind with regard to the reproduction of birds is that the season for breeding is, as a general rule, a very sharply defined fact. The casual observer often draws his knowledge of the subject from the poultry-run. He sees the owner of a stock of poultry drawing a supply of eggs which appears to go on more or less throughout the year with no regard to season or anything else; and when he reads in the newspaper that a hen or duck in an egg-laying test has won with the extraordinary total of over 300 eggs in a single year, he is justified in drawing the conclusion that a bird may be always in laying condition. This is far from the case.

It may be laid down as a general rule that a bird whether male or female, is only in breeding condition for a short and very definite period in the year. There is no need here to discuss the subject in detail. Those of us who are accustomed to collect birds and skin them, have necessarily to ascertain their sex by dissection. In the process one soon learns that the reproductive organs in both sexes lie dormant throughout most of the year. At a certain period they develop and the bird breeds ; after the eggs are laid, the organs again diminish and become so small that they are difficult to recognize. These facts remain true whatever the breeding habits and whenever the breeding season. In the poultry-run, domestication has interfered with the normal cycles. The wild duck or the Jungle Fowl has a defined breeding season, a normal waxing and waning of the organs like any other bird.

In many books one may read apparent contradictions of my statement above. The House-sparrow and the various doves are said to bring up a succession of broods, or a particular species is said to breed throughout the year. Here looseness of language and thought are at fault. In Peninsular India it is quite true that nests of many species are to be found throughout the year. The climate is not one of extremes in many areas ; food-supply is abundant ; there is no particular factor to make one month a better breeding season than another. Thus it comes about that the eggs of a common bird, as for instance the Common Babbler (*Argya caudata*), may be found in a particular area in *any* month in the year, whilst if the bird is sufficiently numerous, nests may be found in *every* month. Individual birds go through their reproductive cycle, some at one time, some at another. The same birds do not breed all the time. The number of broods reared by an individual, do not necessarily differ from the numbers she would rear if exigencies of climate and food-supply directed all the pairs to lay at one time as in more temperate lands. A particular hole in a stable roof may hold a succession of sparrow broods. It does not follow, however, that each brood belongs to the same parents. Competition is severe and suitable sites are often scarce. There is no doubt that the normal brood for most species is a single one ; many species certainly bring up two broods, and a few three ; but there can be little doubt that the number of broods attributed to a species is generally exaggerated, especially in India. Any one who has had to collect birds in the breeding season, will probably bear out my experience that it is very rare to shoot a bird building a nest and find that it bears the unmistakable 'incubation patch' which a recent brood would imply. A bird may build a nest and lay a clutch of eggs. Some fatality attends the eggs—and such fatalities are very numerous in a land of dust-storms, crows, lizards, snakes squirrels and small herd-boys—and the bird immediately proceeds to the production of a second nest and clutch, and sometimes a third endeavour is necessary before a brood is reared. But such second or third attempt does not mean that the bird is 'double-brooded' or 'rears three broods' in the meaning of the text books.

It is akin to that strange phenomenon by which some species can be induced to lay double or treble the normal number of eggs if an egg is daily removed from the nest so that the clutch does not accumulate. The ovary has some selective power of bringing to maturity eggs that would not normally develop.

In my experience the organs of male birds develop for the breeding season in advance of those of the females. From this probably follows the fact that courtship is in most cases the work of the male and also follows the acquisition of a 'territory' by the male as explained below. But before dealing with those points it is necessary to consider the various forms of union into which birds enter. These follow different lines which recall the various usages of mankind.

The normal union is that of one male with one female. This is so general amongst the birds not only of India but of the world, that the point need not be laboured or illustrated, except as regards the duration of such unions. Some are certainly for life ; others are certainly only for a single breeding season. But the facts are not easy to study : and we have little definite knowledge.

It is fairly safe to assume, for instance, that the Raven (*Corvus corax*), the Sarus Crane (*Grus antigone*), and the Laggar Falcon (*Falco jugger*) are species which pair for life. A pair of Sarus Cranes will take up their abode in a particular jheel and there one will find them for the whole year. They rest and for a time they are accompanied by the young. Then the young vanish and the original pair remain in the place where one has always seen them. So marked is the devotion of the pair, one to the other, and so definite their attachment to one particular area that we are justified in considering it amounts virtually to proof that the union is one for life. The oft-repeated legend in India that if one of a pair of Sarus Cranes be shot, the survivor will die of a broken heart shows how definitely and generally it is believed, as the result of unconscious observation, that the birds pair for life.

So with the Raven and the Laggar. They are not birds which catch the notice of every one like the Sarus. But any observant naturalist soon learns certain salient facts in their life history. The nesting place is used year after year ; the pair of birds are seen about together the whole year round ; the same pair appear to have the same area of territory in which they hunt and live, and as acquaintance with them grows, a particular pair is found to have some little trick or habit which helps to establish their identity.

With the Raven there is another item of circumstantial proof. Wherever it is sufficiently numerous it has the habit of roosting in congregations. Early in my service in India I was posted to the Jhelum district, then particularly noted for the number of murders committed in the Chakwal Tehsil. As Assistant, I was usually deputed to hasten out to the scenes of successive murders and this involved a drive of about 40 miles by tonga from Mandra to Chakwal as the railway had not then been built. About halfway along the road there were some wayside trees which a large number of Ravens had chosen as their roosting place. When my journey took place by moonlight I used to see the Ravens, to the number of 20 or 30 or more, sitting asleep up in the trees. When I travelled earlier in the evening I saw the birds flying over the country to the roosting place, and invariably they were in pairs. There were never parties as in the roosting flight of the House-Crow (*Corvus splendens*): there were never single birds. Always I saw pair after pair flying fast over the plain, to join the common roost. One can hardly avoid the conclusion from this that the pair which nested together, lived together throughout the rest of the year.

How far this is the case with smaller commoner birds is difficult to tell. We know that a covey of partridges or a party of tits of genus *Ægithalus* (such as the common Red-headed Tit of the Himalayas), consists in its origin of the pair of old birds with their young. We know that these family parties, if undisturbed, persist together until the spring; and we may suspect that when the breeding season comes again and the parties break up to breed the old original pair probably remain together. We notice a tendency also for many resident birds to be found about commonly in twos, generally of opposite sexes, which suggest that the pair remain together throughout the season. But our definite knowledge on the point is very meagre. It is on points like this that we shall ultimately hope to learn much from the activities of bird-ringers.

On the other hand there is no doubt that great numbers of birds pair afresh each season. It could hardly be otherwise with most of the migratory species. Though the fact that migration is not necessarily a bar to birds pairing for life will probably be admitted by all who have a full acquaintance with the Brahminy Duck (*Casarca ferruginea*). The marked way in which these birds remain in pairs during the winter on our Indian rivers, and the close relation that subsists between the pairs even when a number occasionally collect together, renders the conclusion irresistible that these migratory birds pair for life. In most migratory species, however, the chances are evidently against the same male and female finding each other, season after season.

Monogamy and polyandry are not common amongst birds, though of considerable interest in the cases where they occur. It is difficult to define their extent.

Some years ago it was generally believed that the majority of the larger game birds (*Gallinæ*) were polygamous. Now opinion has swung the other way, and turning over the pages of the new *Fauna*, one finds it asserted under most of the species that they are monogamous. I do not find that either opinion, so far as our Indian species are concerned, has been based on very definite facts or observation. The testimony of natives and the proportions between the sexes appear to be the only facts on which the theory of general polygamy was originally based; and it was confirmed to those who believed in it by the readiness with which birds in captivity fell in with arrangements based on the theory. The point is one which may be commended to observers in the field, but it will not be settled without difficulty.

Polyandry is the name given to the system of one female mating with several males. In India we are familiar with it in the case of the Painted Snipe (*Rostratula benghalensis*) and the little Button-Quails of the genus *Turnix*.

Now there are some very interesting points connected with this reversal of the role of the sexes.

In both the Painted Snipe and the Button-Quails, the female bird is very definitely the larger and the plumage of the sexes is different. To human eyes at any rate the plumage of the female Painted Snipe is more beautiful and conspicuous, the male having to some extent the duller plumage which is commonly associated with the duties of incubation. The Painted Snipe is necessarily a difficult bird to study in its natural habitat, but fortunately the Button-quails are easy birds to keep in captivity; and what we know of their habits in the wild state has been supplemented and confirmed by aviculturalists.

The following facts are believed to be well authenticated. The females have a loud booming call, generally described as a *purr*, or a cross between a *purr* and a *coo*. This call is used for the same purposes as the call of the males of the game birds, that is to say as a challenge to others of the same and an invitation to those of the opposite sex. By the call the males are attracted to the females and other females also come and desperate contests ensue between them. Their pugnacity is so well known that it is utilized by native bird-catchers, who according to Jerdon in the Carnatic used to catch 15 to 20 females with a single female call-bird as decoy.

Once paired, the female is accustomed to feed the male with tit-bits from her bill, just as the males of gallinaceous birds are accustomed to feed their mates.

As soon as the eggs are laid the male begins to sit on them and broods them throughout incubation. When the chicks are hatched he feeds them and carefully brings them up, without any assistance from the hen who in the meantime has usually called and fought for and paired with another male. This male in his turn is furnished with a clutch of eggs to incubate, while it is believed that this succession of mates is often a fairly long one. The female herself never incubates and probably pays no heed to the young.

Promiscuity is not as a rule an avian habit. It is not certain whether it occurs at all normally amongst Indian birds, but I believe that the cuckoos of the genus *Cuculus* are promiscuous in their mating, males and females pairing for the moment and not uniting in a union of any duration. Something approaching this is said to occur with the Likh Florican (*Sypheotides indica*). It is believed that these birds do not pair but that the males have each a particular territory and that the females wander about until they succumb to the fascinations of a male and then they lay and incubate their eggs and rear the young without his help.

Very little is as yet known about the question of Territory, in the sense of a particular area in which a single bird or a pair of birds claim domination, so far as others of their own species are concerned. The sense of Territory is far from general. In many species it certainly does not exist at all. In a few it is strongly marked; in the majority it is probably not very strong, and in almost all cases it is confined to the breeding season.

Now the pugnacious habits of the common Black Drongo or King-Crow (*Dicrurus macrocercus*) are known to every one in India. A pair build their nest in a tree and until the young are fledged and independent, the neighbourhood of that tree is the scene of incessant commotion. The King-Crows attack every passing bird of any size—Eagle, Kite, Crow and often far less dangerous birds—suspecting them of evil designs upon their nest, and other gentler species such as the Doves and Bulbuls often nest in the same tree and doubtless benefit from their protection. Though the King-Crows evidently define limits within which dangerous strangers are not tolerated, this is not a Territory in the specialized sense. The King-Crows are merely protecting their eggs or young from danger and they are not intolerant of others of the same species; in fact other pairs often come and fraternise with them.

A Territory *sensu vera* is maintained with reference to others of the same species. It is most easily understood by an illustration from a Himalayan stream. Camp alongside a Himalayan stream in summer and observe the White-capped Redstarts (*Chaimarrhornis leucocephala*) and the Plumbeous Redstarts (*Rhyacornis fuliginosa*) which are certain to be nesting along it. At regular intervals along the stream you will find pairs of each species. If you watch there you will soon discover two facts. Firstly, the pairs of each species parcel the stream out amongst themselves, so that the stream is divided into sections by the White-capped Redstarts and again into sections by the Plumbeous Redstarts. The sections often coincide for the two species so that each part of the stream lies within a section belonging to each species. Secondly, you will find that in any section the Plumbeous Redstarts and the White-capped Redstarts are not intolerant of each other. Occasional bickerings there will be between White-caps and their smaller relatives, but no more than is usual amongst neighbours. But each pair is very definitely intolerant of the presence of a stranger of their own species. If a Plumbeous Redstart from another section arrives within the territory of the local pair, it is immediately assailed and driven away again, and so with the Whitecapped Redstarts.

Here we have definite *Territories*, easy to see and understand because of their linear dimensions along the stream. In the fields and jungles similar territories exist but they are difficult for human perceptions to grasp without a great deal of careful observation.

It is easy to understand how the territory is started and maintained by resident birds which pair for life. I know a precipice in the Simla Hills where year after year the Shahin Falcon (*Falco peregrinator*) breeds. There are three nesting sites in that precipice used in turn in different years. The birds live there all the year round. They hunt in the neighbourhood, rest after hunting on the face of the precipice and sleep there by night. When they are nesting, woe betide the crow or eagle that ventures to fly across the face of the cliff. With shrill screams the Falcons pursue and buffet the bird till it is far enough away to please them, and so too would they doubtless treat any stranger of their own species. Under such circumstances it would be strange if the Falcons did not come to regard this cliff and its neighbourhood as their own special territory.[1]

With birds that pair for a single season, the importance of the territory varies. For many it certainly does not exist at all. For others its inception is probably delayed until after the nest is actually started, and its origin is merely sexual jealousy.

In many cases however it is believed that the possession of a territory by the male is a necessary antecedent to the obtaining of a mate. This subject has been carefully studied by Howard with reference to the British Warblers, and he came to the conclusion that with the little warblers of the genus *Phylloscopus* (so widely represented as breeding birds in the Himalayas) this was what happened. In the spring migration, the males were the first to arrive. They poured over the country side and as they came, each male in turn took up his abode in a particular group of trees until the locality was filled with the number of males for which there were suitable territories. The remainder passed on to other areas still untenanted—wave passing over wave. Then as the females arrived, they paired with those males already in the possession of territories. Unsettled males are not in a position to mate for they have no territory within which to choose a nest site.

How far this is correct it is difficult to say, but something like it undoubtedly occurs. I have noticed, for instance, how the Pied Bush-chats (*Saxicola caprata*) arrive in spring in the Punjab where they are mostly summer migrants. For a few days there are evidently only males about. They are conspicuous everywhere and a little observation suggests that individuals are stationary, each with its particular area where it will invariably be found. Then the females arrive and nest building begins at once. And so with the Purple Sunbird (*Cinnyris asiatica*) and other species.

Other birds certainly pair before they arrive in their breeding quarters. The Lesser Sand-Plover (*Charadrius mongolus atrifrons*) for instance indulges in all the displays and antics of courtship on the sands of Karachi before it leaves on its long non-stop flight to the breeding grounds in Ladakh and Tibet. Here the birds presumably arrive already paired and mutually select their nesting site.

Here a question immediately suggests itself. Do birds, other than those which pair for life, remember their nesting site from year to year and use it season after season ? The question is very difficult to answer, but it is another of those that we may hope in time to answer through the ringing of birds.

It is evident of course that season after season the nests of certain species may be found in the same place.[2] A particular hole, for instance, will contain the nest of a Tit or a Magpie Robin for several years in succession. Under a particular culvert there is always the nest of a Wire-tailed Swallow (*Hirundo smithii*). A pair of Little Ring Plovers (*Charadrius dubius jerdoni*) always seem to nest on the same shingle bed. But there is usually nothing to show that the birds which nest there one year, are those that bred there the year before. It may be that really desirable sites are scarce and that a site is selected by one pair for the same reasons that influenced its predecessors, or possibly one or both of the birds survive from previous years, remember the site and return to it.

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[1] Such a territory once started, is maintained for generations. See '*Ootheca Wolleyana*', p. 98 in which Peregrine Falcons were discovered as occupying the same eyrie in 1736, 1799 and 1853.

[2] See, for instance, the famous case quoted by Yarrell (*British Birds*) of Blue Tits nesting in an earthenware bottle from 1779 (or 1785) to 1873 with the exception (for special causes) of only 2 years.

The probability would seem to be that all birds desire to nest where they nested before, or where they were themselves brought up; but innumerable chances lie in the way of fulfilment of this desire. Where birds are strictly resident, there should be fewer obstacles in the way, the destruction of the nesting site, its appropriation by a stronger individual or species, and the heavy chance of casualties during the year. But in the case of migrants, the odds are far heavier: for one bird that returns after an absence of months and a journey of thousands of miles to the exact spot of its desires there must be numbers which have fain to be satisfied with a safe return to the general area. That some birds do actually return successfully to the particular nest site has been proved by ringing. That all desire to, is suggested by the following circumstantial evidence :—

It is a commonplace now of knowledge how hard it is to induce migratory birds to return as breeding species to an area from which they have been exterminated. The Ruff and Reeve (*Philomachus pugnax*) and the Black-tailed Godwit (*Limosa limosa*) for instance were once extremely common breeding species in the eastern counties of England. They were exterminated as breeding birds in the course of the last century by heavy destruction of the birds and eggs in the breeding season. Suitable marshes for them still exist where ample protection would be afforded to them; and every spring quite a number of both species pass through on migration, while colonies of both birds are still numerous in Holland but a short flight away. Yet there is no more than an occasional isolated attempt by any of these migrants to breed in their old haunts. The explanation apparently is that all the migrants are tied by unconscious memory—the homing-instinct—to breed where they were bred or had bred before. The local strain whose ties were with the English marshes is dead; and no fresh strain will start there so long as the migrants find their own ancestral marshes available. If by some means a number of pairs could be induced to breed one summer in the English marshes, their descendants would return there year after year and the species be reinstated as a British breeding bird.

Courtship

With these preliminary observations we may turn to an examination of the courtship of birds in the stricter sense of the words. It needs only a slight acquaintance with birds in the field to make one realize that the period immediately antecedent to the building of the nest and the laying of the eggs is one of great activity, more especially on the part of the male. This activity expresses itself in various ways, but in the main these ways fall under two heads. Either the bird expresses its excitement by movement, or by noise—the two most primitive methods in the world of nature.

Within the possibilities afforded by these two methods we find an infinite variety of expression and it is customary to divide them under two headings, display to attract the mate and force to drive off the possible rival ; while together they are held to account for the sexual dimorphism of most birds, acting through natural selection.

Display has a wide range. Pycraft cites the case of the House-Sparrow thus :—' The grotesque manner in which he struts with drooping wings and outspread tail around his mate ' ; and rightly points out that it is nothing more or less than the same type of display which we see in birds like the Pheasants and the Peafowl where the grotesqueness of the performance (in human eyes) are lost sight of in the splendour of the plumage and its special developments that the performance reveals. Between the strutting and posturing of the sparrow and the display of the Peacock (' in his pride ' as the old Heralds aptly emblazoned it) there is no difference save of degree. There is no need to labour examples of the display pure and simple ; each can readily furnish them from his own experience.

It may, however, be of interest to mention one or two examples where for the purposes of display, feather ornament has been reinforced by body structure or behaviour.

A familiar example of the latter is furnished by the Common Iora (*Ægithina tiphia*). In the breading season the male flies up into the air and then spirals down to its perch again, with all the feathers spread out, especially the long loose plumage of the rump, until it looks almost like a ball ; while descending it utters a strange protracted sibilant sound, recalling the note of a frog or cricket. Arrived on the perch it spreads and flirts the tail like a little Peacock, drooping its wings and still uttering the curious note.

Reinforcement of plumage displays by bodily structure is most familiar in the use of air sacs. The stock example is that of the pigeons of the Rock-Dove (*Columba livia*) group with their domestic derivatives. As the male turns and twists and *cooes* before his mate, beak pointing to the ground, he inflates his neck both for the purposes of the noise and to exhibit more completely the lustrous colours on the neck. Here the inflation is apparently merely of the crop and gullet with no special structures in addition.

In the Bustards a special pouch or gular sack, opening under the tongue, has been developed to carry this type of display still further. I do not find that this pouch has been definitely dissected and described for our Indian species[1] *Choriotes nigriceps* (=*Eupodotis*

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[1] Can no sportsman who shoots a male bird preserve the head and neck in spirit for the purpose ?

edwardsi) though its structure is well known in the European Great Bustard (*Otis tarda*). That it exists is evident from Hume's account:—

‘ The way in which the male expands the throat at times during the breeding season in most extraordinary. . . . First the male begins to strut about, holding his head up as high as if he wanted to lift himself off his legs ; then after a few turns, he puffs out the upper part of the throat just under the jaws, then draws it in again, then puffs it out again, and so on, two, three or four times, and then suddenly, out goes the whole throat down to the breast, and that part of it next the latter swells more and more ; his tail, already cocked, begins to turn right back, over the back, and the lower throat bag gets bigger and bigger, and longer and longer, till it looks to be within six inches of the ground. All the feathers of the throat stand out, and looked at in front, he seems to have a huge bag covered with feathers hanging down between his legs, which wobbles about as he struts here and there with wings partly unclosed, and occasional sharp snappings of his bill. From time to time he utters a sort of deep moan, and stands quite still.’

The Adjutant Stork (*Leptoptilos dubius*) is provided with a somewhat similar pouch. When deflated it is hardly visible and appears merely as a conical swelling of bare skin in front of the neck. It differs from that of the Bustard in the speed with which it can be inflated and deflated. It suddenly shoots downward as a large naked windbag of considerable size and as suddenly disappears. It is filled from air sacs opening into the nose but the display in which it is used does not appear to have been described and an opportunity of placing most valuable information on record here lies open to the hand of some member of the society.

How far the presence of these remarkable air pouches in the Bustard and the Adjutant is seasonal appears to be unknown, but in the Frigate-birds (*Fregata*) the large scarlet pouch beneath the throat which can be inflated until it equals the body of the bird in size is evidently acquired in connection with the breeding season.

A variant of this type of reinforcement of plumage by structure is found in the fleshy horns and bibs of the Tragopan Pheasants (*Tragopan*), which are expanded during the display.

It is not strange that pugnacity amongst the males should be a feature of the courtship period of birds ; and such pugnacity often merges with display. General displays at preconcerted meeting places for numbers of birds of both sexes are well known amongst birds. Though such may easily occur amongst our Indian birds I do not recall to mind that any have been actually observed and recorded. Although it is a well-known migrant to India we are not privileged to see the Ruff (*Philomachus pugnax*) either in his tournaments or in his tourney-attire. As we see it in India the Ruff and his consort the Reeve are plain looking brown waders with nothing but size to distinguish the sexes. After they leave India in the spring the male assumes a wonderful breeding dress. The feathers of the face are shed and their place is taken by small fleshy papillæ of bright yellow or pale pink. From each side of the head sprouts a tuft of stiff curled feathers giving the appearance of long ears, whilst below the throat appears a most remarkable frill or ruff of stiff curled feathers over two inches long. The ear-tufts and ruff are very variable in colour ranging from black or white to chestnut, spangled, speckled and barred, and often glossed with violet, blue or green. The ear-tufts and the ruff are very dense and stiff in texture and they are capable of depression and elevation so as to form a shield to the bird.

During courtship the Ruffs select as tiltyards certain eminences in the marshes where they breed. There at day-break the males assemble and regular tournaments go on. To quote from a writer on the subject :— 'The performers assemble at the favoured spot and commence at once to disport themselves, now sparring one with another, and now standing one in front of another with outspread frill and head bent down till the beak rests upon the ground, immovable, only to commence again to spar. Now and again some display of temper is shown, one bird endeavouring to seize another by the beak and administer a rain of blows with its wings ; or the two will rise in the air and strike at each other with their feet. The more vigorous appear to take possession of certain definite areas and to hold these against all comers. Sooner or later the females appear on the scene, when they are courted vigorously by the males, who display their frills assiduously.'

The Black Game (*Lyrurus*) of Europe is another species celebrated for these concerted displays and it may be that some of our lesser known Indian birds indulge in them.

Individual pugnacity is of course a common incident of courtship.

The disreputable scrimmages on the ground in which the House-Sparrows (*Passer domesticus*), the Mynahs (*Acridotheres tristis*) or the Babblers of the genera *Argya* and *Turdoides* grapple and struggle with wings and beaks and legs afford the most obvious examples. Such pugnacity is more developed in some species than in others. The ordinary small passerine bird is not as a rule a very determined fighter. In fact I have always noticed that dash and initiative always counts for more than actual pecks or blows. If one small bird flies at another, the latter almost always gives way without resistance ; a mere dash by a small bird is sufficient to put a large one to flight without their relative strengths being really tested.

Definite fighting is far more developed amongst non-passerine birds ; and in the group where it reaches its apex, the *Gallinæ* it is accompanied by the development of offensive weapons in the form of spurs. The deadly weapon that a tarsial spur is capable of becoming is known to all who have shot the males of the various Jungle-Fowls (*Gallus*) and the extreme pugnacity of this group is evident from the intolerance of the chicken-run. Unless and until one cock is master definitely of the poultry yard, there are incessant conflicts ending perhaps in the death of a combatant.

The tarsial spurs are in all Indian Game birds in pairs, one on each leg, except in the case of the Spurfowls (*Galloperdix*) where the number is irregular and variable, as many as three spurs occurring on a single leg. It does not appear, however, that the extra number of spurs has any connection with a more pronounced pugnacity and one can only conclude that Nature's infinite tendeney to variation has in this case become a generic characteristic.

That the presence or absence of spurs is not correlated with the degree of pugnacity is evident from their absence in the true quails (*Coturnix*), so esteemed in India as captive fighting birds. Spurs are not confined to the legs. The Spur-winged Plover (*Hoplopterus ventralis*) of the great rivers of the Indo-Gangetic plain and the Pheasant-tailed Jaçana (*Hydrophasianus chirurgus*) are well known as possessing a similar spur on the carpal joint of each wing. We are commonly informed that both these species use the spur for fighting at the breeding season, but I personally have never seen either species make use of it and doubt the correctness of the usual statement.

It should be remembered in this connection that the Bronze-winged Jaçana (*Metopidius*) has the radius of the wing broadened out from its middle onwards, in the from of a flat plate, and this is considered by Pycraft to be also intended as a weapon, though this also seems doubtful.

Akin to the ceremonial side of the tournaments held by some birds must be considered the habit of dancing. Virtually nothing has been recorded about this habit amongst Indian birds though it must be practised by some species. That delightful species, the Demoiselle Crane (*Anthropoides virgo*) owes its name not only to its graceful figure but also to its habit of indulging in set dances though these of course take place in its breeding quarters and not in India.

W. H. Hudson in his fascinating writings has recorded elaborate dances by the Cayenne Lapwing, Ypecaka Rail and the Jaçana of South America, but there is no reason why we should not discover that allied birds in India indulge in similar ceremonial. But unfortunately Naturalists in India have devoted much time to collecting specimens and paid little heed to the observations which would reveal so much of interest in the life-histories of the birds they collect.

Akin to the dance is the elaborate ritual of courtship recorded at some length in England for the Great Crested Grebe (*Podiceps cristatus*), another species that we know best as a winter visitor in India. This ritual is said to culminate in a pose when male and female rise high out of the water, breast to breast, each holding a piece of water-weed in their bills.

As stated earlier, noise in some form or other is a very important accompaniment to the courtship of birds. It may profitably be considered under two divisions, vocal and instrumental. To deal with vocal music first :—

It is well-known that a very large proportion of birds signalize the approach of the breeding season by breaking into song. I here use the word song in a liberal sense to include not only those bird-songs which are really worthy of the name but also those monotonous chirpings as of the House-Sparrow (*Passer domesticus*) or loud calls as in the various Cuckoos (*Cuculidæ*) which at the breeding season undoubtedly occupy the place of a true song. To the Koel (*Eudynamis scolopaceus*) and the Brain-fever Bird (*Hierococcyx varius*) the loud incessant calls which drive some human beings to despair fulfil the same function as the wondrous song of the Nightingale. Both are an expression of the sexual excitement of the season ; both are a stimulation to that excitement; and both are a message to the opposite sex. It is easy to see how song developed from the call note. We see the first stages of the development in the shrill and incessant noise of the breeding cock-sparrow who possesses merely his single harsh note as a call but works it with passion into the substitute for a song.

It may not be out of place here to explain that a bird's voice is not produced in the same way as that of other animals. In mammals the vocal chords are in the larynx, at the top of the windpipe; in birds they are situated in a special song-box, the *syrinx*, at the foot of the windpipe where it branches into the two bronchial tubes leading to the lungs. Birds actually possess a larynx, like mammals but in their case it has no connection with the production of the voice.

Anatomically considered, the syrinx is rather an intricate organ and there are many variations in its constituent or accessory parts. In the Cranes (*Grus*) for instance the windpipe (*trachea*) is greatly elongated and the space for the extra length is found in a long chamber formed by the keel of the breast-bone. In the Spoonbill (*Platalea leucorodia*) a figure-of-eight convolution provides for the extra length of windpipe. In many of the ducks there is a special hard resonating sac or 'Sound-box' attached to the side of the trachea. These modifications are by no means properly understood. It does not appear possible to establish any exact correlation between the intricacy of the song and the complexity of the instrument but the more complicated variations in birds are often only found in the male of a species.

It is interesting to remember that in the female of the Painted Snipe (*Rostratula benghalensis*), where as we have seen above the role of the sexes is reversed, there is said to be a convolution of the trachea confined to that sex (though I confess I have so far failed to find it in either sex when I have dissected them).

I have said above that song is an expression, a stimulation and a message of sex-impulses; and that this is true, is clear from the direct connection between song and the hormones contributed to the blood by the reproductive organs. These hormones prompt or inhibit sexual characteristics. The 'breaking' of the voice in young men, the crowing of hens whose ovaries are atrophied or in whom there is development of testicular matter are examples of the connection. But at the same time the fact must not be lost sight of that song is also based on something else than sex. The Wren (*Troglodytes*) or the Dipper (*Cinclus*) that sings amidst the Himalayan snows in the depth of winter is clearly at the moment free from the impulse of sex. There is some metabolism of superabundant energy and excess of well-being that relieves itself in song and it may be that there are vestiges of an æsthetic sense which sings for pure delight in the beauty and the sound of the song. It certainly seems like it.

Whatever the full gamut of feelings to which vocal music amongst the birds is due, it is supplemented by instrumental music. The simplest form of percussion music, says Pycraft, is perhaps that produced by the White Stork (*Ciconia alba*). Throwing the head backwards till the point of the beak almost touches the back, the jaws are set rapidly in motion; clashing one against another and producing a curious rattling sound, which has been compared to castanets. As the sound is being produced the head is slowly turned into its normal position ; but not until the beak has described a half-circle and rests almost on the ground does the music cease. I believe that similar performances are indulged in by other Indian storks but unfortunately there is little on record about them.

More curious is the deliberate drumming by Woodpeckers. It is a favourite habit of many species—In India I have noted it in the cases of *Dryobates sindianus* and *Leiopicus mahrattensis*—to select a rotten branch of a tree as a drum. This they repair to at intervals, I believe only in the early breeding season, and drum on it with their beaks, using the method and producing the effect of the 'rolling' of a kettle-drum. The result is most striking and it is evident that the action takes precisely the place of the song of other birds. It is evident that the Woodpecker is precisely aware of what it is about.

Whether this is so in the case of a Drumming Snipe (*Capella cœlestis*) is harder to understand. The drumming of the Snipe is one of the most famous curiosities of natural history. Unfortunately it is confined to the breeding season; so we in India are never privileged to hear it. My first experience of it took place after my retirement from service.

On these occasions a Snipe mounts high up into the air above the marsh where it is breeding. There it wildly circles about and flies a random zigzag course until it suddenly shoots downwards and aslant and then as abruptly mounts again to its former elevation and this process it repeats again and again. During each descent a sound is heard, variously described as drumming or bleating, but which to my ears is best described as being like the sound of the hoofs of a galloping horse. There seems no doubt that this sound is produced by the passage of the air through the two outer tail feathers which acute observers may see held out separately well in advance of the fan-spread tail. An equivalent noise is made by some of the various other snipes and the possession of this faculty is evidently correlated with the curious variations in the outer tail feathers of the members of this genus.

In writing this chapter it has once more been brought home to me how little we know of our Indian birds. Europe has in the past been lucky in its observers who have set themselves to study and record the extreme interest of the habits of all the more distinctive birds. The result is a mass of material from which other writers have been able to select, and build up various studies and theories of biological significance. The birds of India provide an assembly of interesting and curious forms, the significance of which we are still unable to estimate. For in India the naturalist has been little more than a collector, a fault largely engendered by the fatal ease with which shikaris can be engaged to bring in and preserve a quantity of eggs and birds with little or no trouble to the collector who often contributes little but the labels. I fear that the richness of the Indian avifauna will soon be a thing of the past ; but while it still remains in some abundance, there is still time to observe and record the ways and habits of our birds. If this is done, explanations will be found for the amazing diversity of form and structure which at present are known to us merely as isolated facts.

Biologists have long felt the need of accounting for sexual-dimorphism, that is the fact that amongst birds (and in other groups too) the male is so often larger or more vigorous than the female, and that his plumage is so often more striking and conspicuous. The assumption of special breeding plumages, more especially by male birds, is also remarkable. Darwin thought that the courtship of birds had given him the clue to the explanation. He studied the tournaments of the Ruffs and Black Cocks, the plumage displays of the Peacock and the Bird-of-Paradise, the song of the Nightingale and the other manifold forms of courtship which we have endeavoured to outline above. He thought that behind it all he could find a proof that the more vigorous male—whether vigour were expressed in terms of strength in the duel or beauty in the display and concert—had the first choice of the females, whilst the least vigorous males were left unmated. At the same time he thought there was evidence of preferences shown by the females, that success in the contest of males was accompanied by positive choice by the females. Combining these two factors he arrived at the theory that sexual dimorphism was the result of evolution working through this sexual selection.

There are difficulties in the way of accepting the theory. But although later writers have evolved other theories to account for the facts, one and all have difficulties in the way of their acceptance. In the meantime, there is work for all to do in observing and recording the phenomena of courtship in the hope that a fuller knowledge of the facts will lead to a correct understanding of the guiding principles behind.

THE BUTTERFLIES OF COORG.

BY

J. A. YATES.

PART II

(*Continued from page 1014 of Vol. XXXIV.*)

VIII.—Family. LYCÆNIDÆ.

H 5. 4. **Gerydus biggsii,** Dist. On March 16, 1929, while I was catching on the Paiyaswani River, Sampaje ghat, one of my servants took an obvious Gerydus, identified for me by Evans as *Gerydus biggsii* ♀ : another of my party told me that he too had caught a very damaged specimen, but, not realizing its rarity and novelty, had thrown it away. It was caught on a low branch of a tree on an island in the middle of the river.

H 9. *a*. **Spalgis epius epius,** Wd. This insect, common round Bangalore in the dry jungles where it haunts buushes and small trees, does not seem common in Coorg, at least in the months I have spent in the province.

H 11. **Neopithecops zalmora,** But. Common throughout the province in the intermediate and evergreen areas. Has a lazy flight ; is a low flier round and among trees and bushes. Comes to water.

H 12 *a*. **Megisba malaya thwaitesi,** M. Have only seen it in any numbers in the evergreen country ; and chiefly on damp patches on the roads and on damp sand among stones and rocks by the rivers, notably on the ghats and below the ghats.

H 13 *a*. **Talicada nyseus nyseus,** Guer. Well distributed, and at certain spots abundant. Flies late in the evening sun, until very nearly dark. Have noticed it then settle gregariously along low twigs with closed wings, often on the underside.

H 14. 1 *a*. **Castalius rosimon rosimon,** F.

H 14. 2 β. **Castalius caleta decidia,** Hew.

H 14. 3 *a*. **Castalius ethion ethion,** Db. and Hew.

All three common in Coorg ; on the whole, at any rate in the intermediate and evergreen country, the last two commoner than *rosimon*, which is the usual *Castalius* in the dry country round Bangalore, where *caleta* is rare, and *ethion* (so far as I know) does not occur.

All three are low fliers, *C. rosimon* seems to fly much more in the open sun, round bushes, and over grass and low flowering plants. *Caleta* and *ethion* are distinctly woodland butterflies.

H 15. 1. **Tarucus ananda,** De. N. This beautiful little fly, so far as my experience goes, is much more usual in Coorg than the next. It flies rather high (10′ to 15′) round certain trees, but comes down freely to damp patches. It is found both in the dry forest (e. g., in October) and in the evergreen country, above and below the ghats.

H 15. 2. **Tarucus theophrastus nara,** Koll. I have only seen this at Napoklu in open grass land in March. It is uncommon also round Bangalore, where I have only seen it after the monsoon breaks in June and July. A lower flier than the last.

H 16. 1. **Euchrysops cnejus,** F.

H 16. 2 β. **Euchrysops contracta contracta,** But.

H 16. 3 β. **Euchrysops pandava pandava,** Hors.

All three in Coorg ; *E. contracta* the least common there and round Bangalore. All low fliers in the open, round low plants, bushes and flowers. Settle on damp ground.

H 17. 3 α. **Everes parrhasius parrhasius,** F. Throughout Coorg but never abundant ; at all elevations from near the summit to the foot of the hills. A low flier in the open ; settles on damp ground.

H 20. 5. **Lycænopsis akasa mavisa, Fruh.** Fairly common especially in the evergreen areas and particularly on the ghats. Flies along banks and round trees and bushes, at from 3 to 10 feet or so ; settles on flowers. Occasionally at water.

H 20. 15 β. **L. puspa gisca,** Fruh. Common everywhere. Comes freely to damp earth.

H 20. 16. **L. lilacea,** Hamp. This beautiful butterfly is well distributed in Coorg. ♂♂ are gregarious in their habits at water on damp roads, etc. ♀♀ are rare, and taken singly near or in jungle. Appears to be annual, though more abundant September–October and March–May.

[I have not taken *L. albidisca* and *L. limbata* in Coorg.]

H 21. α. **Chilades laius laius,** Cr. Common in Coorg, both W.S.F. and D.S.F., as elsewhere. A low flier.

H 22. 1 α. **Zizera trochilus putli,** Koll.

H 22. 2 α. **Z. maha ossa,** Swin.

H 22. 3. **Z. lysimon,** Hub.

H 22. 4. **Z. gaika,** Trimen.

H 22. 5 α. **Z. otis decreta,** But.
Throughout the province.

H 27. **Syntarucus plinius, F.** General and common.

H 28. 1. **Catachrysops strabo,** F. Do.

H 29. **Lampides bœticus, L.** Very common.

H 30. 2 β. **Nacaduba pactolus continentalis,** Fruh. I took four ♂♂ in April 1929 on the Sampaje ghat : identified by Evans, as *continentalis*. I thought they were the first specimens caught in S. India, till recently I saw in Col. Winckworth's collection a ♀ taken at Urti in 1927. Those I took were all taken on one short stretch of road near mile 13 from Mercara. Though I spent many hours in looking for other specimens, I could see no more. *N. hermus nabo* was fairly common at that place just then, and *N. pactolus continentalis* settled with *hermus*.

H. 30. 3. **N. hermus nabo,** Fruh. By no means one of the commonest species in Coorg ? ♀♀ are distinctly rare. ♂♂ come down to damp earth.

H 30. 7 α. **N. viola viola,** M. I have found this attractive little insect in various places from the edge of the dry area to the foot of the ghats in the evergreen country. Sometimes it is almost abundant, e.g., in February 1929 on stones and sand by the Paiyaswani River (Sampaje ghat).

H 30. 8 β. **N. atrata euplea,** Fruh.

H 30. 9. **N. akaba gythion,** Fruh.

Both these are common throughout. Like other *Nacadubas* come freely to damp earth.

H 30. 14. **N. nora,** Fd. Abundant in most places.

H 30. 15α. **N. dubiosa indica,** Evans. Common, but not abundant like the last.

H 30. 16β **N. noreia hampsoni,** De N. Rare, if not very rare.

H 30. 17β. **N. dana,** De N. Where it occurs is common, almost gregarious on damp earth. Round Bangalore; I have found it common in places on the flowers of Maddi (*Terminalia tomentosa*).

H 31. 1α. **Jamides bochus bochus,** Cr. Common or at any rate widely distributed. More numerous in the rainy months (June and July) round Bangalore than anywhere in Coorg! not seen at water. Flies round bushes.

H 31. 6β. **J. celeno celeno, Cr.** Common, but in the evergreen area less common than the next.

H 31. 7β. **J. elpis curysaces,** Fruh. Widespread. More of a woodland species than the last.
All three *Jamides* occur throughout the year. *J. celeno* and *J. elpis* vary considerably in colouring and markings according to the season.

H 32. 1. [**Azanus ubaldus,** Cr.]
[**Azanus uranus,** But].
[**Azanus jesous gamra,** Led.]

I have recorded only the first in Coorg. I did not trouble to look for them in Coorg till too late for the purposes of this list. Obtained round Bangalore.

H 33. 1α. **Lycænesthes emolus emolus,** God. According to Evans common, but in Coorg at any rate, it is not. I have only found it on the ghats, in October, January, March, April and then only sparsely: in October on the flowers of a cæsalpina at other times chiefly on damp earth. It does not occur, so far as I know, round Bangalore.

H 33. 2α. **Lycænesthes lycænina lycænina,** Fd. 'Rare' [Evans]. It is however very common and universal in Coorg and in all the jungles round Bangalore, especially on sandal flowers. In Coorg it is plentiful near streams and on damp roads.

H 45. 1 and 2. **Curetis æsopus,** F. and **Curetis thetis,** Dry. Both are common in Coorg, as round Bangalore. I have seen a series drawn up in which the transition from the characteristics of *thetis* to those *aesopus* (♂♂) is so gradual that it is difficult to tell where one begins and the other ends, or a break occurs which would justify a differentiation into two species. There does not seem to be any means of distinguishing ♀ of one from ♀ of the other.

H 45. 6. **C. acuta dentata,** M. This species does not occur round Bangalore: it favours larger jungle and particularly the neighbourhood of streams and rivers. ♂♂ are abundant in many places, e.g. on the Paiyaswani river, on the Nagarhole (eastern forests). The ♀♀ are rare: at any rate hard to get; they do not come out into the open as do ♀♀ of *C. thetis*.

[H 46. 1β. **Iraota timoleon timoleon,** Stoll. May occur; on the eastern side are many trees of the kind of banyan it favours round Bangalore, but I have no record of it. Hannyngton does not mention it.]

H 47. 1β. **Horsfieldia anita anita,** Hew. Hannyngton remarks, 'is rare in the northern open country in June and November'. I have, however, found it in the northern and eastern forests in January, April, May and September and under the Brahmagiri range in October and again from January to May: nearly always fresh specimens were to be had. It would appear to be *annual*. Where it occurs it is fairly plentiful. It seems to favour wooded streams, and comes freely to water in sunny spots or at the debouchment of a stream into open country, in paddy-fields, on flat rocks, etc. In April and May at two spots in the northern and eastern country the specimens I took were underneath nearly black with a purplish tinge. I have not seen it on the ghats.

H 48. α. **Thaduka multicaudata kanara,** Evans. Hannyngton says: 'May be looked for on the western slopes below 2,000 feet in May, August and September, I have taken it at Irpu and Kakkotpole (3,000 feet) above the ghats. It is to be had on the ghats certainly in October, and every month from January to May. I have always taken it near streams or rivers, settled on bushes or trees, but not on the ground at water.

H 50. 34. **Amblypodia canarica**, M. Distinctly rare. I have taken it at Napoklu and Srimangala settled on Neale (Eugenia Jambolana). Also on the Sampaje ghat on lantana and at Watercolli on another Eugenia (C. Eugenia hemispherica ?). I have seen it settle on a wet stone near the Paiyaswani River.

H 50 37. α. **A. centaurus pirama**, M. Occurs both above and below the ghats, in intermediate and evergreen country. At Srimangala I found the *pupa* of a female rolled in a leaf of Nerale (*Eugenia jambolana*), almost ready to emerge.

H 50, 40 α. **A. amantes amantes** Hew. I have taken this abundantly round Bangalore on mango and nirale chiefly. Hannyngton records it in Coorg.

H 50. 46. **A. bazaloides,** Hew. I have only seen and taken this on the ghats on the evergreen forest on the lower parts of the Periambadi and Sampaje ghats. Settled on leaves, e.g. Lantana It is distinctly rare ; taken in October or February.

H 50. 72 β. **Amblypodia abseus indicus**, Riley. I took one specimen (♀) on a wet stone in the shade by the Paiyaswani R. February 1929. It was kindly identified for me as *indicus*, *Riley* by Evans not *mackwoodi* as one might have imagined from the nearness to Ceylon. Apparently the first recorded from S. India.

H 51. 1 β. **Surendra quercetorum quercetorum,** But. In the evergreen country, chiefly on the ghats, flying on the edge of the forest by the roadside. In my experience this is not so common in Coorg as the next.

H 51. 4 α. **Surendra todara todara**, M. Hannyngton records it from Fraserpet or Pollibetta in August, e.g. from the dry and intermediate areas. It is more frequent in the evergreen country and occurs in other months, e.g., on the Periambadi and Sampaje ghats in September and October, and again in March and April; at Napoklu in February and March, and at Fraserpet in May not seen at water. On trees and about bushes.

H 54 β. **Loxura atymnus surya,** M. Well distributed throughout the intermediate and evergreen country. It occurs certainly from September to May on the edge of woods or in woods.

H 57. 3. **Apharitis lilacinus,** M. Evans gives Bangalore as a locality : I have not seen it there, but have taken it at several places in Coorg in evergreen forest; e.g. at Appugala, Irpu road, close to Nalknad Palace and on the Sampaje ghat. In each case it was very local, flying round one or two bushes or small trees, settling on the leaves, darting off and returning. Taken only in February and March.

H 58. 1 β. **Spindasis vulcanus vulcanus,** F.

H 58. 2 α. **Spindasis schistacea schistacea,** M.

Both common.

H 58. 3. **Spindasis abnormis,** M. Recorded by Hannyngton.

H 58. 5 β. **Spindasis ictis ictis,** Hew. Occasional but not common in Coorg, whereas in places round Bangalore it is fairly plentiful, especially in July-August.

H 58. 12. **Spindasis lohita lazularia,** M. This is perhaps the commonest *Spindasis* in Coorg ; at any rate in the evergreen area. At times it is almost abundant, e.g., in W.S.F. on the Periambadi ghat after the monsoon in September-October. D.S.F. occurs from December to April, when W.S.F. begins to appear again. It particularly favours, as do other Lycænids, the flowers of *Clausena indica* (?). It occurs also in the intermediate and dry areas, e.g., at Fraserpet in May. Not seen on the ground, as *S. schistacea.*

H 59. **Zesius chrysomallus,** Hub. I have taken only one bad specimen, (♀), in Coorg ; it had no blue on the upper wings. I have however taken it freely round Bangalore in certain jungles, especially jungles where there are many yellow tree ant nests, in which it has its larval and pupal stages. There appear to be clearly distinct W.S.F. and D.S.F. The former appears in June and continues till about November. In W.S.F. the copper red of ♂♂ is darker and has a bluish tinge. In D.S.F. the red is paler without the blue tinge. In D.S.F. also the underside is less distinctly marked, the red of the spots in extreme D.S.F. (e.g., in April) almost disappearing. Similarly the blue of ♀♀ in W.S.F. is deeper and more metallic than the blue of D.S.F., which is slightly chalky with a tint of brown underneath. The underside D.S.F. also is paler than W.S.F. and the marks less pronounced than W.S.F. ; the red of the spots tends almost to disappear.

H 61. 3 α. **Pratapa blanka sudica,** Evans. Distinctly rare : I have taken only ♂♂, (1 on the way to Marinad from Hudikeri, (2) on the Sampaje ghat. One was taken on a leaf by the way side ; the rest were taken on the ground, having come down from a high branch of a tree.

H 61. 4 α. **Pratapa deva deva,** M. No record. It should be in Coorg.

H 61. 7. **Pratapa cleobis,** God. Certainly rare in Coorg, but apparently more widely distributed than *P. blanka sudica* : I have it from Madapur (N. Coorg), Bhagamandala (W. Coorg), and Urti (below the ghats). All were taken on bushes or low trees.

H 65. 15. **Tajuria jehana,** M. Only one record from Coorg. It may, however, be commoner in the dry forests. It occurs in many jungles round Bangalore on a small white-flowered acacia.

H 65. 16β. **Tajuria cippus cippus,** F. I have only taken it in the intermediate area. It is common in many jungles round Bangalore and occurs in most months of the year.

[The probable reason for my getting so few of either of these *Tajurias* in Coorg is that having got plenty round Bangalore I was not on the look out for them.]

H 65. 21α. **Tajuria jalindra macarita,** Fr. I think this must be very rare in Coorg ; I looked for it for two years, but only got one specimen (♀) on wet sand by the Paiyaswani river in deep shade.

H 75β. **Cheritra freja jaffra,** But. Fairly common in all evergreen wood, round bushes and trees and near the edge of jungle.

H 81. **Rathinda amor,** F. Not common in Coorg, where I have only seen stray specimens : this is the case at least in the intermediate and evergreen areas. Not as in some of the dry jungles round Bangalore at times, e.g., after the rains break, in June and July, almost gregarious and abundant on *Eugenia jambolana*, etc.

H 82. 1α. **Horaga anyx cingalensis,** M. Rare, have only found it in the evergreen country, e.g., at the top of the Periambadi ghat, at Madapur, Napoklu and on the Paiyaswani River. Settles rather high on the leaves of low trees.

H 82. 4. **Horaga viola,** M. I have not taken it. Col. Winckworth took one at Urti at the bottom of the Periambadi ghat. Very rare in Coorg.

H 83. 1α. **Catapoecilma elegans myositina,** Fruh. Throughout the evergreen country, but not common. It often settles on the leafless twigs or on the flowers of *Eugenia hemispherica* (?). Both above and below the ghats, and in most months.

H 84. 1. **Chliaria othona,** Hew. Is certainly one of the rare *lycænidæ* in Coorg. It occurs sporadically both in the deciduous evergreen forests ; e.g., at Fraserpet in January, and in the evergreen, Nalknad and the Paiyaswani River. Generally on trees or on flowers ; but occasionally on damp earth.

H 86. **Zeltus etolus,** F. I first took this in December at Urti. Later at mile 155 on the Periambadi ghat road. On the Sampaje ghat, near the Paiyaswani River, 13 miles from Mercara, ♂♂ were plentiful from February to April. ♀♀ are rare and seen to keep inside the jungle. ♂♂ settle frequently on damp earth. It appears to be confined to the thick evergreen jungle and damp heat.

H 88. 1α. **Deudoryx epijarbas epijarbas,** M. Common in Coorg, as round Bangalore, upon flowers.

H 89. 1. **Virachola isocrates,** F. Common, but not so common as the last. Taken on flowers.

H 89. 3*a*. **Virachola perse ghela,** Fruh. Appears to be rather uncommon in Coorg, as it is round Bangalore. Occurs in dry, intermediate and evergreen areas. Taken on trees (e.g., cinnamon) and on flowers (e.g., of a large *Osbeckia* and a tall purple composite).

H 90. 5. **Rapala lankana,** M. A rare, if not very rare, insect, I have only seen it on the ghats or in the hot forest below the ghats. Taken on flowers (e.g., *Clausena indica* (?), and a *Cæsalpina*).

H 90. 10*a*. **Rapala varuna lazulina,** M. Fairly common throughout. Taken on leaves and flowers.

H 90. 11. **R. schistacea,** M. Common.

H 90. 15. **R. melampus,** Cr. I took this very commonly near Bangalore ; and regret that I did not note its frequency in Coorg. It is I think fairly common.

[*Note.*—I have not seen any *Rapala* on the ground at water. They all seem to affect trees and bushes—feed greedily at flowers.]

H 92*a*. **Bindahara phocides moorei,** Fruh. This beautiful insect can be had in most months from September to May—the months of which I have experience in Coorg—in the evergreen forest of the ghats, generally near streams or rivers. It is an insect that seems partial to a locality or a particular plant : if found once on the flowers of a particular *clausena indica* it may be found there at another season. Most frequent September–October and April–May.

VIII.—Family HESPERIIDÆ

I 1. 6β. **Hasora badra badra,** M. 'Not common' (Hannyngton). I have looked in vain for this insect.

I 1. 12. **Hasora alexis alexis,** Fab. Common as elsewhere : throughout the province.

I 1. 13*a*. **Hasora taminatus taminatus,** Hub. Both above the ghats and on the ghats, in intermediate and evergreen country. It favours stones and sand by the side of streams, especially in the forest and debouching from the forest, springs by the roadside on the ghats and damp spots on the roadside. Also on flowers especially early in the morning and late in the afternoon ; e.g., on lantana.

[*Note.*—Hannyngton in his list gives
263 *Hasora chabrona*, Plotz. Bhagamandala, January.
265 *Hasora badra*, Moore. Not common.

Now *Hasora chabrona, Bl.* = *Hasora vitta, But*, which is not S. Indian : it is of the *badra* group. Can it be that by *Hasora chabrona,* of which he got a specimen or specimens only in January at one place he means *Hasora badra ?* And that by *Hasora badra*, which he describes as not common he means *Hasora taminatus taminatus ?* The latter is not common certainly, but it is not rare : and in five years Hannyngton could not have failed to gather more than one specimen or to have found it at only one place.]

I 2. 5*a*. **Ismene fergussoni,** DeN. 'Fairly common in the evergreen belt, especially in the monsoon' (Hannyngton). Also, after the monsoon in September–October, and again in May. I have seen it in N. Coorg beyond Somwarpet, in the intermediate area. Flies and feeds on lantana, verbena, etc., early in the morning and towards dusk. Disappears in the day time.

I 2. 13*a*. **Ismene gomata kanara,** Evans. Recorded by Hannyngton as on the ghats during the monsoon.

I 3. **Bibasis sena sena,** M. 'Eastern Forests. Annual' (Hannyngton). I took on a specimen at the foot of the ghats in evergreen country.

I 5. *a*. **Rhopalocampta benjamini benjamini,** Guer. 'Northern forests in June and September' (Hannyngton). Also evergreen country above the ghats ;

e.g., Heggala (October), Swamimale (February) and Kakkotpole (May). By no means common. Taken in shade on flowers and on the ground in the morning and late afternoon.

I 6. **Badamia exclamationis,** Fab. Common throughout the year.

I 1 6. 1. **Celaenorrhinus ambareesa,** M. 'On the ghats during the monsoon' (Hannyngton). Also in May and September. Taken on flowers in the morning sun. Not common.

[I assume this is Hannyngton's *C. spilothyrus*, Felder : though I admit there is resemblance. If, however, *C. spilothyrus* really occurs, of which I have no personal record, then *C. ambareesa* is additional to Hannyngton's list.]

I 16, 13*a*. **C. leucocera leucocera,** Koll. 'Common from May to October on the western slopes' (Hannyngton). Also throughout the evergreen area above the ghats. Where found obtainable in other months of the year, but less commonly than in the rainy season.

I 16, 19*a*. **C. ruficornis area,** Plotz. 'Not common on the Periambadi ghat in September' (Hannyngton). It is not so common as *C. leucocera*, but is not uncommon ; also in October and more rarely in other months. On other ghats also, and above the ghats in evergreen country.

All these *Calaenorrhinus* are rather shade-loving insects : flying into the open in the morning to feed on flowers, and for the rest preferring half-shady glades or openings into the forest.

I 20. 4β. **Tagiades obscurus athos,** Plotz. Throughout the intermediate and evergreen country 'annual' (Hannyngton).

I 20. 9 x. **Tagiades litigiosa vajuna,** Fruh. Throughout the intermediate and evergreen areas. Annual. [*Tagiades atticus* : in the bamboo (South Coorg) and ghats (Hannyngton)].

I 24. 3*a*. **Daimio bhagava bhagava,** M. I give this with hesitation. Hannyngton includes *Satarupa bhagava, Moore :* Eastern forests ; May to October. I am unable to identify this. I have not taken it : Col. Winckworth has *Daimio bhagava* from Kallar (Nilgiris).

I 25. 1*a*. **Coladenia indrani indra,** Evans. '*Coladenia tissa, Moore*. Pushpagiri, May : Fraserpet and Titimati, July and August (Hannyngton). Also in the ghats and above the ghats in February, March, April and September. In September 1928 a ♀ taken has cilia *hw* not white but brown and fawny. This insect is also found round Bangalore.

I 25. 2 *a*. **Coladenia dan dan,** Fab. Common throughout Coorg and at all seasons. It does not occur, so far as I know, in the dry jungles round Bangalore.

I 26. 2. **Sarangesa purendra,** M. 'November to January' (Hannyngton). I have not taken it in Coorg and do not know its locality.

I 26. 3 β. **Sarangesa dasahara davidsoni,** Swin. 'June to September' (Hannyngton). It certainly occurs after September, till May. Annual and common in the evergreen area at least.

I 28. 1 β. **Tapena thwaitesi hampsoni**, El. 'One male on May 8, at Srimangala, S. Coorg' (Hannyngton). Rare but obtainable at several places, in evergreen areas above and below the ghats. At Watecolli in September 1928 (♂, ♀) on flowers of *ramtulasi* (verbena). February to March at Ajjemada stream, below the Brahmagiri range ; January to April on Sampaje ghat (13½ miles from Mercara) and on Paiyaswani River ; and May at Kakkotpole (Marinad crossing). Like *Odontoptilum angulata* and *Caprona ransonnetti* favours damp earth, on which it lies with spread wings. I have seen it, whether by chance or by instinct for self-protection, several times settled on damp black camp ashes, where bullock drivers had stopped.

I 31. 1. **Odontoptilum angulata,** Fd. 'Eastern forests, May to September' (Hannyngton). It occurs also at many places in the intermediate and evergreen areas, and is widely distributed and even common ; obtainable every month from September to May, probably annual. Settles with flat wings on damp earth on roads and by streams.

I 32. 1 α. **Caprona ransonnetti potiphera,** Hew. 'May to October' (Hannyngton). It occurs throughout the province from the deciduous to the evergreen area and is, so far as I have observed, to be had in any month between October and May. Like the last two in its habits. Common in Coorg. Rare round Bangalore.

I 34. 1. **Hesperia galba,** Fab. 'Annual' (Hannyngton). Common : low-flying in the sun on grass and on low flowering plants.

I 54. β **Astictopterus jama olivascens,** M. Not given in Hannyngton's list. Occurs in both W.S.F. and D.S.F. the latter in January and February or probably earlier, at Mercara. I have not seen it outside the evergreen area. A relatively weak flier : flies low along banks.

I 56. 2. **Baracus hampsoni,** El. 'Annual' (Hannyngton). Is there a D.S.F. ? I have taken fresh specimens in the drier months that are not bright ochreous brown below, but an ochreous grey.

I 57. 1. **Ampittia dioscorides,** F. 'Eastern forests, May to September' (Hannyngton); also in the intermediate and evergreen country at other seasons, e.g., Somwarpet (intermediate) in January and Watecolli (evergreen) in May.

I. 58. 5 α. **Aeromachus pygmaeus pygmaeus,** Fab. 'Annual' (Hannyngton). It may be added very common and in all areas.

I 60. 1. **Arnetta vindhiana,** M. 'Annual' (Hannyngton). It appears to be found chiefly on the ghats, also at Mercara.

I 61. 2 α. **Iambrix salsala luteipalpus,** Plotz. 'Annual' (Hannyngton). Universal, throughout the province ; flies low in clearings, round bushes and under trees ; settles on flowers.

I 62. 1 α. **Suastus gremius gremius, F.** 'Annual' (Hannyngton) and common ; well distributed.

I 62. 3 α. **Suastus rama bipunctus,** Swin. 'Annual but not common' (Hannyngton). I have not taken it in Coorg.

I 67 α. **Sancus pulligo subfasciatus,** M. 'Western slopes in the Monsoon' (Hannyngton). It is very common then and afterwards up to October, but occurs less abundantly later up to May. Annual. Frequents flowers, e.g., *Ramtulasi* and *lantana.* A rather floppy flight on the edge of the jungle. Belongs to the evergreen area.

I 73. 1. **Udaspes folus,** Cr. 'Annual' (Hannyngton). Found in all areas. Flies low, in and round bushes and under trees. Frequents flowers and comes freely to water, on stones, etc., by the side of streams.

I 74. 3 α. **Notocrypta paralysos alysia,** Evans. Abundant at times, e.g. after the Monsoon, September and October. Chiefly in the evergreen area. 'Annual' (Hannyngton).

I 74. 5. **N. curvifascia,** Fd. Flies with the last, but is much less common.

I 75. 1 β. **Gangara thyrsis thyrsis,** F. 'S. Coorg and the ghats in the monsoon' (Hannyngton). It occurs again towards the end of April. I have taken it in October also.

I 80. 1. **Matapa aria,** M. 'Not common, but widely distributed' (Hannyngton). Flies inside or on the edge of jungle ; occasionally on flowers. Taken in October, January, March and May ; all in evergreen country.

I 82. 1 β. **Hyarotis adrastus adrastus,** Cr. 'S. Coorg and the ghats in the Monsoon' (Hannyngton). Also, immediately after the Monsoon. It is then commonest, but occurs in other months, e.g., January to May. Generally on flowers on the edge of jungle, and in the half shade.

I. 82. 2. **Hyarotis basiflava,** DeN. Hannyngton says he found this fairly common in September 1913 on the flowers of *Strobilanthes barbatus.* 'As this strobilanth is reputed to flower only once in 7 years, possibly this butterfly will escape observation till 1920 '. In 1927 it was taken (one specimen on *Ram tulasī* (verbena) at Watecolli.) In 1928 September I took a couple at Watecolli in the early morning expanding their wings on the leaves of a cinnamon tree, and several on the Periambadi ghat near mile 152 on *Ram tulasi*. Strobilanthes grows near both spots, but was not in flower. The butterfly disappeared afterwards. I should say it is very rare in Coorg.

I 83. 1. **Itys microstictum**, WM. ' Now *Kineta* ', (Evans). I took two ♂♂ and one ♀, which Evans kindly identified for me. The ♀ I took early one morning in April 1929 sunning its wings near mile 13 from Mercara on the Sampaje ghat; a ♂ flew away into the forest. Later on about 1 p.m. I took a ♂ feeding on the flowers of *clausena Indica* (?) in the shade. A few days later I took another ♂ feeding also on the same flowers in a stream leading up from the old forest tramway to Solekolli from Urti (Periambadi ghat), also in the shade. Evans writes in his note: ' Hitherto only recorded from Cachar, Burma, etc. Always very rare and very variable. I have only a few specimens and I have more than in any museum. The ♂ corresponds very well with one of my ♂♂ from the Ataran valley but the ♀ is curious in having the spot over the middle of the cell so strongly developed: in only one of my ♀♀ is there any more than a trace of it. However there is no doubt about the identification. Swinhoe redescribed it as *Arnetta binghami*. *Itys* is preoccupied and has recently been replaced by ' *kinetta* ' I have given ♀ and ♂ to the British Museum.

I 87. 7 *a*. **Plastingia submaculata kanara**, Evans. I wonder if this is what Hannyngton names *Pedestes sala*, *Hew* (Yes, *Ed.*). I am unable to trace *pedestes sala*, whereas *Plastingia submaculata kanara*, *Evans* belongs to the *sala* group of *Plastingia*. I took one specimen at Watecolli in May 1928; Col. Winckworth has another specimen taken in October. I missed another at Watecolli. It is evidently a rare butterfly: I made repeated efforts to get another, but failed. The one I caught flew out of an opening into dark forest and was feeding on lantana after dusk, when *Ismene fergussoni* was also feeding.

I 99. 4. **Halpe hyrtacus**, DeN. ' Western ghats ' (Hannyngton). In September and October (1927–28) it was fairly common at Watecolli on lantana and *ramtulasi*; I fear I neglected opportunities, not realizing its rarity. I have taken it on the Sampaje ghat (13½ miles from Mercara) in January and again at Watecolli in April.

I 99. 8. **Halpe sitala**, DeN. ' Nagarhole, eastern forests in May: one specimen ' (Hannyngton). I have not seen it.

I 99. 15. **Halpe astigmata**, Swin. ' Western ghats in the monsoon ' (Hannyngton). It is almost abundant on lantana, etc., after the monsoon in September and October; and occurs also later in January and on till May; in the last month it becomes common again. Found also above the ghats in evergreen country.

I 99. 22. **Halpe honorei**, DeN. Widely distributed from the eastern forests to the evergreen; occurs in North, Central and South Coorg. Hannyngton gives only the Western ghats. I do not know about the monsoon months, but it is to be had every other month, but is at no time common.

I 99. 26. **Halpe moorei**, Watson. ' Annual ' (Hannyngton). I have one specimen, taken in Malambi forest, N. Coorg in May.

I 99. 33 *a*. **Halpe homolea ceylonica**, M. ' Western ghats ' (Hannyngton). It is widely distributed throughout the evergreen and intermediate areas, above and below the ghats, and occurs throughout the year. It is, I think, the commonest *Halpe* in Coorg.

I. 103. **Cupitha purreea**, M. Not in Hannyngton's list. It is one of the rarities in Coorg. I have seen it only in evergreen woods, Madapur (N. Coorg): Watecolli, Makut (below the ghats) and Sampaje ghat. In each case I took it on flowers.

I. 104. 1. **Nicevillea concinna**, El. ' I have only come across this on the Western slopes in the monsoon ' (Hannyngton). My captures were in September and October just after the monsoon.

I 104. 2. **Nicevillea gola,** M. 'Annual' (Hannyngton) and common: widely distributed. Commonly taken on leaves, sunning itself; also on flowers.

I 105. 2 β. **Taractrocera mævius flaccus,** F. 'A single specimen near Fraserpet in August' (Hannyngton). It occurs in many places, in all areas, and in other months—e.g., Watecolli in May. Fairly common.

I 105. 4 α. **Taractrocera ceramas ceramas,** Hew. Not in Hannyngton's list: obviously an oversight. It occurs commonly in open grass country, e.g., on the grassy slopes of the hills, Tadiendamolu, etc: certainly from September onwards.

I 106. 7. **Padraona dara pseudomaesa,** M. 'Annual' (Hannyngton) and very common throughout year.

I 106. 8 β. **Padraona sunias tropica,** Plotz. Common and annual. The variety *palnia* (Evans) occurs. This and *Pseudomæsa dara* are everywhere; they settle on leaves and spread their hind wings, keeping the fore wings more or less erect.

I 108. 1. **Telicota augias augias,** L. 'Annual' (Hannyngton). Not nearly so common as the next.

I 108. 2 α. **Telicota pythias bambusae,** M. Common in Coorg as elsewhere.

I 115. 1 β. **Baoris oceia farri,** M. Presumably Hannyngton's '*Parnara plebeia, DeN.* Annual.' Fairly well distributed through the evergreen country, but not common.

I 115. 5 α. **Baoris sinensis subochracea,** M. (= Hannyngton's '*Parnara prominens, M.* Western slopes, August.') It also occurs above the ghats; I have one damaged specimen from the Eastern forests, and several from Aggemada stream. This Baoris comes freely to water, and settles on stones. It is rare in Coorg.

I 115. 6 γ. **Baoris mathias mathias,** Fab. The larger dark form *agna* occurs abundantly on lantana, etc., on the ghats after the monsoon and occasionally later. Very common and annual.

I 115. 14 β. **Baoris kumara kumara,** M. 'Annual' (Hannyngton). Occurs throughout the province from dry to evergreen, but is commonest in the evergreen country.

I 115. 15 β. **Baoris philippina philippina,** HS. Not in Hannyngton's list. It occurs in the evergreen country and occasionally in the intermediate. Is undoubtedly rare: chiefly in September and October, in my experience; on the ghats on flowers.

I. 115. 18 α. **Baoris conjuncta narooa,** M. [Hannyngton's 'Parnara conjuncta HS. Western slopes, August'] It occurs on the ghats also in September and October; also December to February: and above the ghats at Irpu and Ajjemada stream in February and March; at Mercara in May; Fraserpet, May. Thus it is found in all areas. Comes out of the jungle early to feed and then disappears inside. Comes out again in the late afternoon.

I 115. 23. **Baoris contigua,** Mab. (= Hannyngton's Parnara toona, M. 'Annual'). It is distinctly rare I think, in Coorg. It occurs on the ghats and above the ghats, so far as my experience goes, only in evergreen country. Taken only on flowers.

I 115. 28β. **Baoris guttatus bada,** M. 'Annual' (Hannyngton), and fairly common; throughout the province.

I. 115. 29. **Baoris canaraica,** M. 'Western slopes, May-August' (Hannyngton). I have it from other areas and in other months. Above the ghats from beyond Somwarpet in N. Coorg; from Irpu and Ajjemada stream (S. E. Coorg); from Ponnampet in the intermediate area. The form which occurs from January to March (early) differs from the monsoon or W. S. F. (See *Journal of B. N. H. S.*, vol. xxxiii, No. 4, p. 1000, note by Evans on specimens sent him from Coorg.) This butterfly does not fly much in the open after 10 a.m. It comes out of the forest on a dewy morning, expands its wings on leaves in the sun and flies back again; but feeds on flowers such as *Ram tulasi*. I have, however, taken it when cloudy on the ghats in the middle of the day.

I 115. 30 β. **Baoris zelleri colaca,** M. 'Annual' (Hannyngton) common as elsewhere, e. g. round Bangalore.

I 115. 31 β. **Baoris bevani bevani,** M. 'Annual' (Hannyngton). But both Col. Winckworth and myself failed to get it for a long time. For two years I had been in hopes, but always failed. Eventually I got it without doubt at Ajjemada Stream (under Brahmagiri Hills) in February and March: probably it is there in other months. It appears to be a retiring insect. It flitted up and down a rocky and shady stream, settling on stones where there was a patch of sun. One or two came out into the open at the debouchment of the stream from forest into cultivated land; where also *Baoris subochracea, Baoris conjuncta, Baoris canaraica, Tapena thwaitesi* and *Horsfieldia anita*—to mention only a few of the more desirable species—emerged. In my experience *B. bevani* is rare in Coorg, whatever it may be elsewhere.

THE PROBLEM OF EVOLUTION

BY

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Part I

Experimental Modification of Bodily Structure.

The problem of evolution is one that has, within recent years, attracted the attention of numerous workers in very different branches of scientific research. It is a problem that affects the Chemist and Physicist equally as much as the Botanist or Zoologist or even the Psychologist, and if ever the problem is to be solved, it will require the combined efforts of all these workers.

What then is life ? It does not usually require any very great knowledge or ability to tell whether a thing is living or not ; but bound up in the act of living are a number of different and often complicated processes. All the possibilities and potentialities of the most complex animal or plant are inherent in and originate from the smallest and most primitive member of the great biological kingdom. A living organism, whether it be as small as an *amœba* or as large as a whale, is capable of carrying on such complicated changes as are necessitated by—

(1) The ingestion or taking in of food ;
(2) The digestion or the preparation of food that has been ingested, thus rendering it suitable for
(3) Assimilation or the building up of the materials derived from the food into the tissues of the animal ;
(4) Respiration or the taking in of Oxygen and the giving out of Carbon Dioxide gas ;
(5) Irritability or the reception and transmission of impulses and sensations ;
(6) Movement, either of the animal as a whole or of its integral parts ;
(7) Excretion or the getting rid of waste products ; and
(8) Reproduction or the carrying on of the race.

All these functions are performed by the substance that we know by the name ' Protoplasm ' and, so far as we know, each mass of protoplasm, if it is to perform all these functions, must contain a small central body termed a nucleus. Now protoplasm is a highly complex chemical substance consisting of an aggregate of molecules and these in turn are built up of atoms. Each atom consists of a number of ions in a state of constant movement, and certain Physicists[1] have reached the conclusion that life originates from a dual system of these ions. As one of them describes it, 'certain ions assume an intra-atomic position, thus forming an immaterial Z-system which is incapable of chemical combinations; the other enveloping ions constitute the material Y-system, the development of which is controlled by the immaterial Z-system which leaves the material one at death. Living matter is invariably of dual constitution . . . . In the living organism, life is an intra-atomic quantity and itis this which determines the living state . . . . The possibilities of the evolution of any forms that arise are strictly limited. Most existing species would be only specific and fixed in essentials, since the limit of their evolution was reached long ago, because of the constitutional limitations of reactions possible to a life form. When this limit is reached the species becomes fixed.' That is a summary of the conclusion reached by a Physicist and whether we understand it or not, there are but few Zoologists, I imagine, who would be inclined to admit that the majority of species have reached the limit of their evolution; let us, however, examine such evidence as we possess regarding the possibility, or the reverse, of such a statement being correct.

Commencing from the first living organism, there has been an uninterrupted line of descent till we reach the present forms that are inhabiting the world to-day. As has been pointed out, the son is not merely 'a chip of the old block'; he is a direct descendant not only of his father and grandfather but of the very earliest forms of animal life. Species are *not* discrete forms of life; they are, on the contrary, portions of a continuous stream or flow that has been going on through countless ages in the past and may continue to go on through the future; from time to time the direction of the stream has been changed and has split into two or more channels but there has been no break in the continuity.

One of the first stages in the course of evolution was the change from the non-cellular to the multi-cellular state and the consequent formation of a body. Specialization of function, however, had appeared in the animal kingdom long before this cell-formation, for in the non-cellular organisms we get evidence of definite organs, such as a mouth, motile organs, such as flagellæ and cilia, excretory organs, as the contracting vacuole, and a controlling centre, the nucleus. What then was it that caused so fundamental a change as that from the non-cellular state to the multi-cellular condition? These non-cellular organisms, the Protozoa, normally undergo growth and development and then by a process of fission give rise to two or more daughter cells that separate and in their turn grow and divide; and one suspects that some change occurred either in the animal itself or in its surroundings that led to the inability of the daughter cells to separate and thus, with a loss of independence, gave rise firstly to a multinucleate protoplasmic mass, or syncytium, and then to a colony of cells, which is the first stage in body-formation. Such a syncytial condition is actually met with in nature among the Protozoa. In these, as in other higher animals, the control of the functions of the cell rests ultimately with the nucleus and there is a direct relationship between the nucleus and the cell mass. In the more primitive forms we find a single nucleus in the animal, though in more advanced forms we may get two or more nuclei in the single protoplasmic mass; in other words these forms are *synctia*. As a rule the cell mass and the number of nuclei have a very definite proportion; though this porportion may change at different stages in the life history or in different external conditions, such as variation of temperature or increase of food. As evidence of this I may cite the work of Popoff[1] on *Paramœcium* and that of Looper[2] on *Actinophrys*. If now in such an animal the amount of nuclear material, which may be in the form of one or more nuclei, be upset, the amount of protoplasm in the animal, and hence its total size will, as a rule, be altered in a corresponding ratio, though this ratio may for a time be upset. Henger[3] has shown that in *Arcella dentata*, a Protozoon with normally two nuclei, one nucleus can be removed. On reproduction talking place, individuals with only one nucleus are produced and the animal is of smaller size, and, furthermore, such individuals appear for several generations. This result is particularly interesting for we appear to have here a definite temporary transmission of an acquired traumatic character. The condition is not, however, permanent, for ultimately the bi-nuclear form will be restored by a process of aborted fission, the nucleus undergoing division but not the protoplasmic mass itself, so that we again get two nuclei in the one animal and now the size of the animal is found to be larger than the original bi-nuclear ancestor, but this condition also only persists for a time and ultimately the size becomes normal again. Comparable results were also obtained in *Arcella discoides*. A similar result has been obtained in one of the primitive plants, *Spirogyra bellis*, under the influence of cold, some of the cells becoming greatly increased in size and possessing enlarged nuclei; and such cells have bred true for over a year.[4] This change in the relationship of nucleus and cell mass is however not universal, for it has been found by Burnside[5] that biotypes of unequal size are not produced by inequalities in the amount of nuclear material in *Stentor*

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[1] 'What is life?' by Augusta Gaskell, with an introduction by Karl T. Compton and Raymond Pearl. Published by Charles G. Thomas, Springfield, Illinois, 1928

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[1] Popoff, M. 1909. 'Experimentelle Zellstudien, II Uber die Zellgrosse, ihre Fixierung und Verebung.' *Arch. f. Zellforsch.*, Vol. iii, p. 124.

[2] Looper, J. B., 1928. 'Cytoplosmic fusion in *Actinophrys sol*, with special reference to the Karyoplasmic rates.' *Journ. Exper. Zool.*, Vol. i, p. 31.

[3] Hegner, R., 1920. "The Relations between Nuclear Number, Chromatin mass, Cytoplasmic mass, and shell characteristics in four species of the genus *Arcella*.' *Journ. Exper. Zool.*, Vol. xxx, p. 1.

(A number of further references to this subject are given in the three papers quoted above. *R.B.S.S.*)

[4] Gerassimoff, J. J., 1902. 'Die Abhangigkeit der Grosse der zelle von der Menge ihrer Kernmasse.' *Zeitschr. f. allg. Physiol.*, Vol. i, p. 220.

[5] Burnside, L. H., 1929. "Relation of body-size to nuclear size in *Stentor cœruleus*' *Journ. Exper. Zool.*, Vol. liv, p. 473.

cæruleus. That a tendency towards incomplete fission of a parent cell and the consequent formation of a large or "monstrous" form, with an increased cell mass and an excess of the normal number of nuclei, exists in nature can be proved by traumatic injury of an individual or by the effect of drugs, X-rays, or overcrowding on cultures of these non-cellular animals; in such cases we get the production of monstrous forms in which two individuals are partially fused together in consequence of incomplete fission, or even of an apparently normal single cell with double the normal number of nuclei and a consequent increase in the bodily size. Even without the direct application of any abnormal condition such individuals may occur and it has been recorded that in a culture of a protozoan, *Uroleptus mobilis,* on one occasion two individuals came together in the normal process of conjugation but after the usual interchange of nuclear material, when, as a rule, the individuals again separate, this separation did not take place and the result was the formation of a double or monstrous form. This double individual subsequently underwent division and bred true, the offspring also being double, for as many as 367 generations.[1] Similar examples of double organisms have been recorded in *Glaucoma scintillans* by Chatton[2] and in an amicronucleate *Oxytricha* by Dawson.[3] In this latter case twinning occurred in a normal culture and from these twins a pedigree strain was bred for 102 generations before the culture died out.

It thus seems probable that the first stage in the process of evolution was that in which the nucleus of the cell undergoes division but the protoplasm of the animal body is unable to form isolated cell masses. This syncytial condition is met with in the ectodermal layer of the sponges and is found even as high in the animal scale as the birds, in which the earliest formation of the developing ovum is also a syncytium. Still later, the condition is reached in which the body is composed of separate and discrete cells, and we get the formation of a colony.

Associated with the change from a syncytial condition to the cellular state there was of necessity a radical change in the conditions of life under which certain members of the colony live. Now the first essential of any body is that it must have a definite shape and structure. In the very lowest of the Metazoa this shape tends to be a sphere. Commencing from a single cell, subsequent division into numerous daughter and granddaughter cells, that may spread in any direction unless restrained by contact with some foreign object, is bound to give us this type. The first stage was thus in all probability the production of a more or less spherical mass in which all the cells were situated on the periphery, the interior of the colony being hollow. Such a condition is found to-day in the animal *Sphærozoum* and in *Volvox*, that is claimed by both Zoologists and Botanists. As soon as a colony becomes solid there is of necessity a differentiation of function. With the increasing organization of the animal body certain parts take on definite functions and for the proper performance of these it is necessary that the parts occupy certain equally definite positions in the body. Clearly, those cells that are situated on the outside are in a position to receive stimuli from the surroundings or to capture food particles, take up the gases necessary for life, etc., while those in the centre of the mass are completely cut off from these functions. In accordance with this change in conditions we find a differentiation of function in the constituent parts of the body-mass; one group of cells, connected with the exterior, takes on the function of receiving and transmitting stimuli; another group of cells becomes adapted to the performance of movement and are known as muscle-cells, others take on the function of support, for a colony or body of any size must have some supporting mechanism; another group of cells takes over the process of digestion, while others again serve the function of excretion. Finally, we get one group of cells whose sole function is that of reproduction and the maintenance of the race. With this formation of a body there goes hand in hand the absolute necessity for the formation of discrete cells, each having a definite surface area. The cells of the body continue to perform many of the functions that we have seen to be inherent in Protoplasm, namely, assimilation, response to stimuli, movement, and excretion. All this activity necessitates the continual taking in of oxygen and the giving out of carbonic acid gas, to wit, respiration, and this process, as well as the taking in of food and the giving out of dissolved excreta, can only be carried out through the surface of the cell. There must, therefore, be a certain definite square area of surface for every cubic unit of cell-substance; and we seem here to have an explanation of the fact that all such cells are of small size.

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[1] Calkins, Gray N., 1925. '*Uroleptus mobilis.* V. The history of a double organism.' *Journ. Exper. Zool.*, Vol. xli, p. 191.

[2] Chatton, F., 1921. 'Rèversion de la scission chez ciliès Rèalization d' individus distomes et polyenergide de Glaucoma scintillans se multipliant indefinitement par scissiparite.' *Conts. Rends. Acad. Sci.*, Vol. clxxiii, p. 393.

(I have not been able to refer to this paper *R.B.S.S.*)

[3] Dawson, J. A., 1920. 'An Experimental study of an amicronucleate *Oxytricha.* II. The Formation of double animals or twins.' *Journ. Exper. Zool.*, Vol. xxx, p. 129.

If, now, we compare the conditions of life of the various groups of cells in the body with the primitive non-cellular animals, one cannot fail to see that, associated with their specialization of function, there has gone, not only a loss of independence, but a gradual loss of certain powers; and it is this loss of function that I wish to emphasise. The first power that most, if not all, of these groups have lost is that of digestion; originally digestion took place within the cell, the food particles being ingested and then digested, but in the higher multicellular animals even the stomach cells or those of certain glands intimately connected with the process, such as the salivary glands or the pancreas, only produce the digestive ferments, the actual process of digestion being carried on outside the cells themselves in the cavity of the stomach and intestine. Again, with the exception of the genital cells, all the others have lost the power of continuous reproduction, since this is, apparently, dependent on occasional conjugation with a similar cell from another colony, or in the higher animals with fertilization between the ovum and spermatozoon. The result of this loss of function is that these specialized cells can only reproduce their kind for a limited time. As you are all doubtless aware, tissues can now be grown and cultivated *in vitro* in the same manner as bacteria, and it has been shown that under such conditions the cells continue to reproduce by what is known as the amitotic method.[1] The time during which such a tissue culture may be continued may actually exceed in duration the normal period of life of the animal itself, but whereas the life of the animal can be transmitted to its offspring, that of the culture must ultimately come to an end.

The essence of reproduction is the ability to initiate and subsequently to direct the differentiation of the daughter cells that result from the continued division of the parent cell. This process, which in the highest members of the animal kingdom resides solely in the genital cells and has been completely lost in all the others, was not lost suddenly. In many of the lower animals we still get the power of reproducing the whole animal from a small part, and in such comparatively highly organized animals as the Crustacea or even the lower Vertebrates we still find the capability of reproducing lost parts.

During development in the higher animals, the ovum divides and re-divides and these resulting daughter-cells have an ultimate destiny that under normal conditions is definitely fixed. From the cells of the 'blastula' stage arise the three primary layers, Epiblast, Mesoblast, and Hypoblast, and each of these, as we know from our observations, gives rise to definite parts of the body and serves definite functions; epiblast is essentially the layer from which is derived the outer covering of the body and the organs of the senses; mesoblast gives rise to the muscles of the body and the supporting skeleton; and hypoblast forms the digestive organs. Under normal conditions there is a definite polarity in the ovum from which the body is developed, certain parts of the egg-cell giving rise to definite structures; in certain cases this polarity clearly depends on the position of the egg and is the result of the interaction of a number of forces, conspicuous among which is gravity. One very good example of this is to be found in the egg-capsules of the common cockroach (*Periplaneta australis*). In this animal the female lays a capsule containing 16 eggs arranged in two rows and as development proceeds these eggs all develop in exactly the same way; the embryo is always situated from the very first with the head towards the crenated ridge that runs along the top of the capsule and the ventral aspect of the larva is turned inwards towards that of the corresponding larva on the opposite side of the capsule. It seems clear that this fixed position is due to the forces acting on the egg, for one can hardly suppose that the mother cockroach invariably places all the separate eggs in exactly the right position. It has further been shown that in the very early stages of development out of the original four cells produced by the division of the ovum two can be destroyed and yet the other two will give rise to a complete and perfect animal, while in one of the mammals, an Edentate, the nine-banded Armadillo, a female at each litter produces four offspring, all identical and of the same sex, each having arisen independently from one of these four cells.[1] It is thus clear that even the polarity of the egg is not absolutely fixed and this seems equally to be the case even in the highest forms, for Newman[2] in his studies on Twins has shown that in the human being the fixation of the body-form does not exist in the ovum but is developed at some stage after the development of the egg has begun. But it appears probable that this fixation occurs at an ever earlier stage as we pass up the animal scale.

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[1] Murray, Margaret R., 1927. 'Cultivation of Planarian Tissue.' *Jour Exper. Zool.*, Vol. xlvii, p. 467

There can, I think, be little doubt that among lower animals the developing body is influenced by its surroundings to an extent that we, at the present time, but dimly appreciate, and this was probably still more the case in the past among the lower organisms, in which the body was and is far more plastic than it is in higher animals. Can anyone, who has studied the work of Loeb and his school, doubt that the general shape of the body is *not* a matter of haphazard mutations, some of which proved to be favourable, while others were unfavourable and so were ultimately destroyed by natural selection, but is due to the action on the organism of definite forces and influences ? I have already pointed out that differentiation of the body into various organs is met with in the lowest animals, such as the Protozoa. When such animals reproduce by fission into two there is a differentiation of the protoplasm into such organs as the animal possesses, so that each daughter-cell is fully provided with mouth, nuclei, excretory organs, and the like, but we also in these animals meet with the exact opposite phase for a process of dedifferentiation is carried out both before conjugation and also before encystment, and in this phase the gullet, the vibratile membranelles, and other structures tend to disappear. Such dedifferentiation may also occur spontaneously in a culture, to be followed again by redifferentiation, the animal once more reforming its lost parts. In somewhat higher animals this process becomes even more striking. Let us take the case of the Hydroid *Campanularia ;* if this animal be brought in contact with a solid substance it shrinks up into a shapeless mass, but if it be then restored to its natural surroundings it once again reforms itself into stalk, body, tentacles, etc., and whichever way one turns the shapeless mass the final product is the same, the stalk is at one end and the tentacles at the other. We thus get a new *Campanularia* whose structure and parts are not due simply to its internal organization but are so much a direct reaction to external forces and conditions that the point where the re-growth shall begin may be fixed at the will of the experimenter. The change is not a mere reversibility from a fully-formed animal to a blastula or syncytium but is a completely new process. Again in an animal such as *Hydra*, which normally has a mouth at one end and a base at the other, we can by altering the position of the animal reverse the formation or even produce a double condition, there being a mouth at each end. Similar results have been obtained in other members of the Hydrozoa, such as *Corymorpha*. In this latter animal, a cut piece of the stalk will normally regenerate a head and tail from opposite ends of the cut piece with the head up and the tail down, so that there would at first sight seem to be a definite polarity. Child,[1] however, has shown that if a piece of the stalk be treated with certain chemical reagents of a strength sufficient to inhibit growth but not to kill the organism, this polarity is upset and on being returned to normal conditions heads and tails may appear in almost any direction and even from the middle of the growing portion. Very similar effects have, again, been produced by Julian Huxley[2] on the developing larvæ of certain Echinoderms; he has shown that the effect of transitory immersion in weak solutions of certain poisons, such as KCN, $ZnSO_4$, Hg-salts, etc., or even starvation, may produce dedifferentiation, the larva losing its characteristic shape and degrading into an unmodified mass of cells. If this mass be then removed from the harmful solution before the process of poisoning has gone too far and is again placed in sea water, redifferentiation into a normal larva with its various structures is possible. This process of dedifferentiation and redifferentiation of the body is in certain cases a normal process and has been brought to a high degree of perfection in the Insecta, where we find that during the pupal stage such changes take place in most of the different parts of the body, so that the structure of the final adult animal, the imago, is very different from that of the larval stage, the caterpillar.

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[1] Pearce, A. S., 1929. General Zoology ' Revised Edition, p. 291, New York.

[2] Newman, H. H., 1928, ' Studies of Human Twins,' *Biol. Bull.*, Vol. lv,

We can, however, carry matters further than this. The work of Wilson[3] and others has shown that in the sponges the animal can be broken up into its constituent cells, by first mincing finely and then straining the resulting fragments through a fine sieve, and yet these individual cells will subsequently come together again and will actually unite to form a sponge once more. Similar experiments performed on Hydroids, such as *Pennaria tiarella* and *Eudendrium carneum*, show that the individual cells first unite to form an undifferentiated mass and from this mass a complete regeneration of the animal takes place, both ectoderm and endoderm being reformed. In this re-formation of the animal it has been shown that the most primitive type of cell, the amoebocyte, can reproduce most of the other types of cells, whereas such specialized cells as the desmocytes and choanocytes can only reproduce their own kind. In certain cases, such as in *Moniezia*, it has been shown by Child[4] that the dedifferentiated cells can actually become converted into germ cells.

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[1] Child, C. M., 1927. 'Modification of Polarity and Symmetry in *Corymorpha palma* by means of inhibiting conditions and differential exposure.' *Journ. Exper. Zool.*, Vol. xlvii, p. 243.

[2] Huxley, J., 1922. 'Dedifferentiation in *Echinus* larvæ and its relation to Metamorphosis.' *Biol. Bull.*, Vol. xliii, p. 210.

[3] Wilson, H. V., 1911. 'On the behaviour of the dissociated cells in Hydroids, Alcyonaria and Asterias.' *Journ. Exper. Zool.*, Vol. xi, p. 281.

[4] Child, C. M., 1906. 'The development of germ cells from differentiated somatic cells in *Moniezia*.' *Anat. Anzieger*, Vol. xxix.

Further research along such lines has shown that the regeneration of the animal after dissociation is actually specific in character, thus if the cells of two different species such as those of *Microciona* and *Stylotella* are mixed, the cells of each species will coalesce but not those of different species, thus cells from *Microciona* will unite with other cells from *Microciona* but not with cells from *Stylotella*.[1] There would thus appear to be a definite attraction between cells of the same species, so that they tend to unite together and under the influence of the external surroundings this union must be carried out in a perfectly definite manner.

As we pass up the scale of the animal kingdom we find that this power of dedifferentiation and redifferentiation and hence the power of regeneration of parts of the body is gradually lost. For a full account of this interesting phenomenon of regeneration I would refer the reader to the exhaustive work of Korschelt.[2] In many of the higher invertebrates and even in the Amphibia and Reptilia of the vertebrates there still resides the power to regenerate parts that have been lost, though in the case of the more evolved forms this seems to be limited to the external structures, such as the limbs in certain Amphibia or the tail in some of the lizards, but when we arrive at the highest vertebrates all that the animal is usually able to do is to heal the damaged part by the formation of scar tissue. Yet even in these higher states of life we find that there still resides in the developing embryo a certain power to form organs and parts from cells that normally would not give rise to them. It has been shown that in the developing larva of *Amblystoma punctatum*, the normal ear, as in all vertebrates, develops from an otic vesicle that is budded off from the brain ; if, however, this otic vesicle be removed, the tissue round the site, that normally would take no part in the formation of the ear, can to some extent take the place of the vesicle that has been removed and forms an ear of sorts, while if the vesicle be transplanted to some other part of the body, it undergoes much less development than in the normal situation, though it still develops into an ear.[3] Again if the developing optic cup, which is also an outgrowth of the brain be transplanted to the thorax or abdomen, the skin over it will form a lens. There is thus some reaction between the various parts of the body that has a direct influence on the development of the various organs, the presence of one organ causing a characteristic development of the cells in the immediate neighbourhood ; such a process is known by the name ‘ correlative differentiation.’

As evolution proceeds there has been acquired a stability or fixation of the bodily form so that the developing embryo is but little, if at all, affected by gravity or other normal external conditions : there is thus a definite arrangement of organs and structures,

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[1] Galtsoff, Paul S., 1925. ‘ Regeneration after dissociation, I, Behaviour, of dissociated cells of *Microciona prolifera* under normal and altered conditions.’ *Journ. Exper. Zool.*, Vol. xlii, p. 183.

[2] Korschelt, E., 1927. ‘Regeneration und Transplantation.’ Berlin.

[3] Kaan, Helen W., 1927. ‘Experiments on the Development of the ear of *Amblystoma punctatum*,’ *Journ. Exper. Zool.*, Vol. lxvi, p. 13,

so that in examples of any given species there is but little variation and the organs do not encroach on one another. The mechanism that thus controls the character of the individual parts is generally supposed to be the production within the developing body itself of certain chemical substances, known as Hormones, that circulate in the blood and control all the various developing masses. In the Crustacea it has been shown that growth is not uniform throughout the body but that certain parts grow more rapidly than others and that the rate varies in the two sexes. These Crustacea, which develop by a series of moults, are particularly suitable for a study of this kind, involving the accurate measurement of the various parts of the body and limbs and a mathematical analysis of the proportions in each succeeding stage. In the Copepoda the most rapid growth in the body occurs at a level of the 3rd segment of the abdomen and from this point the rate of growth becomes less as we pass either forwards to the cephalothorax or backwards to the furcal rami. In certain appendages of the crabs *Uca* and *Maia*,[1] we find similar areas of rapid growth or, as they are termed, growth centres near the tips of the thoracic appendages. Similar results have been obtained in the crab *Inachus* by Shaw ;[2] by Tazelaar[3] in the appendages of the Indian prawn, *Palæmon carcinus*, and by Kunkel and Robertson[4] in the Amphipod *Gammarus chevreuxi* Sexton. In the Copepoda again the main growth centre in the 1st antenna is situated at about one-third of the length of the appendage, namely in the 9th or 10th segment. The increase in size, or ' heterogonic ' growth, is found to differ in the two sexes and is associated with the development of the secondary sexual characters and in such cases we appear to have two factors at work, the ordinary hormone that controls development in both sexes and a sexual secretion that modifies the degree of development in either sex.

From the evidence that I have put before you, and I may perhaps here be permitted to point out that I have only given you a fraction of all the evidence that has been accumulated during the past few years, it would seem clear that the development of an animal is dependent partly on external influences and partly on internal conditions and the cases that we have been considering point to the conclusion that in the lower animals it is the external conditions that exhibit the greatest influence and, furthermore, that in the lower forms of the Metazoa the whole animal, even when adult, can be profoundly modified by changes in its environment, whereas, as we pass up the animal kingdom this effect of the environment becomes less and less and its place is taken by an internal regulating mechanism, existing in the living animal itself. If this be so, then by altering these external conditions we should be able to produce changes in the development and structure of the lower animals and but little, if any, in the higher. Numerous methods of affecting such alteration will doubtless occur to many of you; during the past years an enormous number of such experiments have been carried out and in the time that is left at my disposal I can mention only a few. I have, therefore, for the most part confined my attention to those experiments in which such changes of environment have been utilized as might reasonably be supposed to have occurred in nature, or those similar to such changes. The various functions of protoplasm, as all will admit, are brought about by, or at any rate are accompanied by changes in the constituent atoms and molecules. It has been thoroughly well established that the characters of an animal are transmitted from parent to offspring by minute particles, known as ‘ genes ’, that are connected together in the chromosomes of the nucleus, and two workers, Przibram[1] and Morgan[2] have independently put forward the view that these genes are individual molecules. Any alteration in the ionic movement in or the atomic composition of these protoplasmic molecules must presumably result in an alteration in the character or composition of the protoplasm itself and so of the animal as a whole. A nerve-impulse, travelling along a nerve, is accompanied by an electrical change that can be demonstrated and similarly a contracting muscle also gives an electric response, due apparently to a change in the physico-chemical condition of the protoplasm at the moment of contraction. By the activity of the protoplasm complex chemical substances are broken down into more simple substances and energy is set free; such a process is known as ‘ katabolism ’. On the cessation of activity, or even during its continuance, simple substances are built up into complex bodies, a process known as ‘ anabolism ’, while other substances, the result of the breaking down of the energy-forming compound, that are unsuitable for the future use of the body, are got rid of by excretion; and corresponding changes must have been going on in all organisms, in whatever stage of development or evolution, since life first appeared on the earth. These activities, then, can be set in motion or varied by changes in the physico-chemical conditions surrounding the organism or cell and, like all chemical processes, can be slowed or accelerated by appropriate changes in the surroundings. Changes in the viscosity of the protoplasm of the non-cellular organism can be brought about by various salts, some producing liquefaction, others causing a gelation and solution,[3] while the influence of certain chemical salts on the activity of the cells of the body is well known to all students of physiology. It is also well known that a rise of temperature accelerates chemical changes and the same holds good of living matter. In so-called cold-blooded animals, in which the temperature of the body varies with that of the surroundings, a rise of temperature is accompanied by an increased velocity of movement[1] that is directly proportional. On the other hand, a lowering of the temperature causes a slowing of the frequency of the heart-beat in *Daphnia*.[2] If this lowering of the temperature is rapid there is a definite lag before the slowing of the heart-beat reaches equilibrium ; and this lag possesses a time-factor that corresponds with and appears to be due to the increase in viscosity of protoplasm as a result of cooling. Again an alteration in temperature will considerably affect the rate of development, a higher temperature accelerating it and a lower causing retardation. The rate of division (fission) in *Paramœcium* can be increased or retarded by corresponding changes in the temperature.[3] In the case of the eggs of certain Insecta (Orthoptera), the difference in rate of development has been found to be strictly proportional within those limits of temperature at which it is possible.[4] So dependent on the temperature is the rate of development that if one side of an egg only be heated, then development on that side will be more rapid than on the other and the embryo will become bilaterally asymmetrical. But the changes brought about by alteration in temperature may be much deeper seated than this and not only the rate but the whole character of the developing animal may be changed. Monstrous forms can be produced in a culture of *Paramœcium caudatum*[5] by reducing the temperature to 3°C. and then allowing it to rise again to the normal temperature of the room. Every student of Zoology knows that changes in the season may so affect the Water-flea, *Daphnia pulex*, that the female, which during the summer months has been producing parthenogenetic eggs that develop into females, will with the onset of autumn commence to produce thick-shelled eggs that develop into males and the same is true of other Cladocera. Probably, this is to some extent the result of a lowered temperature causing corresponding delay in development, somewhat similar to the results obtained by Hertwig, who has shown that delayed fertilization of frogs' eggs causes an increase in the number of males. Temperature changes, however, may in a similar manner even affect the animal after it has left the egg stage ; Witschi[6] has shown that the effect of extreme heat on tadpoles is to cause a change of sex from female to male.

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[1] Huxley, J. S., 1927. 'Further work on Heterogonic growth.' *Biol. Zentvalb.*, Vol. xlvii, p. 151.

[2] Shaw, M. E., 1929. ' A Contribution to the Study of relative growth of parts in *Inachus dorsettensis.*' *British Journ. Exper. Biol.*, Vol. xi, p. 145.

[3] Tazelaar, M. A., 1930. ' The relative growth of parts in *Palæmon carcinus.*' *British Journ. Exper. Biol.*, Vol. vii, p. 165.

[4] Kunkel and Robertson, 1928. 'Contribution to the Study of Relative Growth in *Gammarus chevreuxi.*' *Journ. Mar. Biol. Station, Plymouth*, Vol. xv, p. 655.

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[1] Przibram, Hans, 1929. ‘Quanta in Biology.’ *Proc. Royal Soc. Edinburgh*, Vol. xlix, p. 224.

[2] Morgan, 1922. ‘On the Mechanism of Heredity.’ *Proc. Royal Soc. London*, Series B, Vol. xciv.

[3] Brinley, Floyd John, 1928. ‘The effect of chemicals on viscosity of protoplasm of *Amoeba* as indicated by Brownian movement.’ *Protoplasma* Vol. iv, p. 177.

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[1] Przibram, Hans, 1909. 'Aufzucht, Farbwechsel, und Regeneration der Gottesanbeterrinnen (Mantidae). III. Temperatur und Vererbungsversuche.' *Archiv fur Entwicklungsmechanik*, Vol. xxviii, p. 561.

[2] Belehrădek, Jan., 1928. La ralentissement des réactions biologique par le froid est causé par une augmentation de la viscosité du protoplasm.' *Protoplasma*, Vol. lii, p. 317.

[3] Mitchell, William H., 1929. 'The division rate of *Paramœcium* in relation to temperature.' *Journ. Exper. Zool.*, Vol. liv, p. 383.

[4] Bodine, J. H , 1925. 'Effect of Temperature on rate of Embryonic development of certain Orthoptera.' *Journ. Exper. Zool.*, Vol. xlii, p. 91.

[5] de Garis, C. F., 1927. 'A genetic study of *Paramœcium caudatum* in pure lines through an interval of experimentally produced monster formations.' *Journ. Exper. Zool.*, Vol. xlix, p. 133.

[6] Witschi, 1928. 'Studies on sex-differentiation and sex-determination in Amphibians.' *Journ. Exper. Zool.*, Vol. lii, p. 267.

Normally, sex differentiation occurs in the 4th week or after 28 days; but in those tadpoles that had been exposed to a temperature of 32°C. for varying periods, there was not a single female, though in the control eggs Witschi obtained 26 of each sex. In those treated with heat he found that 53 showed changes towards the male condition and 62 were typical males. There can be no doubt that the effect of the exposure was to so alter the genital organs that they changed from female to male.

Goldschmidt has found that a temperature of 37°C. is able to produce deep-seated effects on fruit flies and, finally, Plunkett[1] has shown that an increase in temperature causes a change in certain characters in *Drosophila melanogaster*, one result, among others, being the diminution in the numbers of hairs on the segments of the body.

Mere alteration in the normal conditions of light and darkness may set up deep-seated changes in the animal. As an example I may cite the effect of absence of light on the Aphidæ. In continuous light wingless Aphids produce, almost exclusively, wingless offspring. If, however, the exposure to light be reduced, then winged offspring will commence to appear; the most effective proportion of light and darkness in the production of winged forms is 8 hours' sunlight to 16 hours' darkness and the effect on the character of the offspring makes its appearance in two days. If, however, darkness be combined with starvation, the effect is even more marked and the production of winged forms begins after only 16 hours.[2] It has recently been claimed that changes in the amount of nutrition may of itself affect the ultimate sex of the 'Flour beetle' *Trebolium confusum* Duval.[3] The sex-ratio is in this case not a simple relation of the nutritional condition, for slight starvation of the larvæ (i.e., 1 day) causes an increase in males and more prolonged starvation an increase in females. The author suggests that a certain number of specimens of either sex may have the sex changed to that of the opposite and that this is brought about by the biochemical and biophysical state of the body fluids acting on the germ cells. These effects, I would point out, however they be produced, are not on the animal itself, but on the germ-cells within the body of the animal, the effects being thus only visible in the next generation. A condition of semi-starvation may, however, produce changes in the individual if applied early enough. In the case of *Drosophila melanogaster*, Plunkett[4] has shown that, if applied in the early stages of life, it may cause the production of forms with a marked decrease in the number of hairs on the body, while Casteal[5] by exposing embryos and larvæ has produced changes in the pigmentation of the eyes: but both these effects are comparatively, trivial and, indeed, may almost be termed pathological.

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[1] Plunkett, Charles R., 1927. 'The Interaction of genetic and environmental factors in Development.' *Journ. Exper. Zool.*, Vol. xlvi, p. 181.

[2] Shull, Franklin A., 1928. 'Duration of light and the wings of the Aphid *Macrosiphum solarifolii*.' *Zeitschrift Wiss. Biol.* (Abt. D.) Roux. Arch. Entwicklungsmech. Organ, Vol. cxiii.

[3] Holdaway, F. G., 1930. 'Nutritional Status and sex determination.' *Nature*, p. 131.

[4] Plunkett, Charles R., 1927. 'The interaction of Genetic and Environmental factors in Development.' *Journ. Exper. Zool.*, Vol. xlvi, p. 181.

[5] Casteal, Dana B., 1929. 'Histology of the eyes of X-rayed *Drosophila*.' *Journ. Exper. Zool.*, Vol. liii, p. 373.

In certain of the insects, such as the bees, it is now recognized that we get in nature a variety of forms, the production of which appears to be due to differences in feeding in the early larval stage, and it has been proved that the addition of a substance such as Manganese salts to the food of one of the Butterflies will result in the production of a melanotic mutation that breeds true.

In the case of Rotifers, Tinesinger has shown that when the female parent was subjected to traces of alcohol, there was a marked shortening of life and a reduction in the number of eggs that were laid; and this latter character is transmitted to the offspring for two generations and then disappears. A similar result was obtained by Noyes.[1] Stockard[2] has got results of the same nature in a mammal, while Chaudhuri[3] has shown that injection of alcohol into the male parent mouse very considerably alters the sex-ratio in the offspring, the number of male offspring being increased; in birds, however, Pearl[4] only obtained a reduced fertility in the egg, and those which were fertilized gave rise to perfectly normal offspring. Whitney[5] has found in Rotifers that whereas a scanty diet produces in the second generation only females, a copious diet causes the appearance in the second generation of 95 per cent males, thus showing that there is, as a result, a change in the eggs from which the daughters develop and that this change affects the grandchildren. A similar result has been obtained by Shull in his studies of the effect of external conditions, such as a manure solution, on the sex-determination of the offspring; he found that whether a female is to be a male producer or a female producer, is irrevocably decided in the growth period of the parthenogenetic egg from which that female hatches, that is, before this egg is actually laid, the effect of the external condition thus being on the *grandparent.*

If variation in the amount of sunlight or the amount or quality of the food-supply can produce such effects, one would expect to find that such agencies as ultra-violet radiation, radium-rays, and X-rays were even more efficient, and such is undoubtedly the case. Taking first the effect of ultra-violet radiation on the noncellular Protozoa, it has been found that exposure to such rays for periods as short as from two seconds to two minutes, either every day or on alternate days, is sufficient to produce well-marked results in a culture of *Chilodon uncinatus*,[1] a holotrichous ciliate of the family Chlamydodontidæ ; a number of modifications were produced among which were (1) a race that closely resembled a different species, *Chilodon cucullus*, and this modification continued for generation after generation for months and even persisted after encystment and (2) the production of a tailed form that bred true for 48 generations ; other changes were the production of fused individuals or twins, similar to those that I have already mentioned (*vide supra*, pp. 4, 14). The effects produced may be summarized into the following groups :—

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[1] Noyes, Bessil, 1922. 'Experimental studies on the life history of a Rotifer reproducing parthenogenetically.' *Journ. Exper. Zool.*, Vol. xxxv, p. 225.

[2] Stockard, Charles R., 1918. 'Further studies on the modification of germ cells in mammals; the effect of alcohol on treated guinea pigs and their descendants.' *Journ. Exper. Zool.*, Vol. xxvi, p. 119.

[3] Chaudhuri, A. C., 1928. 'The effect of the injection of alcohol into the male mouse upon the secondary sex ratio among the offspring.' *Brit. Journ. Exper. Biol.*, Vol. v, p. 185.

[4] Pearl, Raymond, 1917. 'The experimental modification of germ cells' I, II, and III. *Journ. Exper. Zool.*, Vol. xxii, pp. 125, 165 and 241.

[5] Whitney, D. D., 1907. 'Determination of sex in *Hydatina senta.*' *Journ. Exper. Zool.*, Vol v, p. 1.

(1) Mutations that continue after encystment and conjugation.
(2) Modifications that persist for some time and bred true, but die out with encuctment or conjugation.
(3) Temporary variations which disappear after 3 generations, and
(4) Abnormalities that cause death.

It has been found in practice that the effects of these types of radiation on developing higher animals are not produced uniformly but that there is a much more marked effect in certain regions of the animal body than in others, the effect apparently depending on the activity of the part. The work of Hyman and Bellamy[2] has shown that the various organs of a body are not all equally active ; thus in sponges the region round the osculum, or the exhalent aperture, is more active than the rest of the body ; in Hydroids the tips of the tentacles are more active than the body and this latter more than the stem : in Medusæ the tips of the tentacles and the margin of the umbrella are most active, while in flat-worms the two ends are more active metabolically than the central part. In a developing animal there is a definite metabolic gradient ; as a rule the head end is metabolically the most active, but this may, at any rate in part, be due to the complexity of this region for it has been found that the rate of metabolism is definitely related to the complex character of the organ, the more complex the greater the metabolic activity. Now the higher the metabolic gradient the more susceptible is the part to outside influences such as radiation or poisons.

Experiments on the developing hen's egg[3] showed that if the rays were directed against the shell, no results were obtained, but if a window was made in the shell, so that the rays could pass through, then a number of changes took place, among which were the production of double monsters or the duplication of parts. One result obtained showed that whereas there is normally a definite polarity in the developing egg, certain parts giving rise to definite organs, the effect of radiation is to stop the development of certain organs and the growth takes on the characters of a neoplasm or tumour. The parts most affected are those that have been shown[1] to possess the greatest metabolic activity, such as the developing Primitive streak, the special sense organs, limb buds, and those regions where foldings or flexures are about to take place.

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[1] MacDougal, Mary Stuart, 1929. 'Modifications in *Chilodon uncinatus* produced by utlra-violet radiation.' *Journ. Exper. Zool.*, Vol. liv, p. 95.

[2] Hyman and Bellamy, 1922. 'Studies on the correlation between metabolic gradients, electric gradients, and galvanotaxis.' *Biol. Bull.*, Vol. xliii, No. 5.

[3] Hinrichs, Marie A., 1927. 'Modification of development on the basis of differential susceptibility to radiation.' *Journ. Exper. Zool.*, Vol. xlvii, p. 309.

The effects of radium rays or X-rays are very similar to those of ultra-violet radiation, but in the majority of instances the effects produced are pathological in character ; Müller has dealt with the effects of radium and X-rays and Babcock and Collins have studied the effects of emanations from radio-active rocks on fruit-flies.

There is thus ample evidence that it is possible to modify the processes going on in an animal by changes in either its external or internal environment. But in nearly all these cases that we have been considering it is found that in the higher animals, changes in the environment, if applied to the adult, produce as a rule little or no direct modification and where any effect is produced, the result lies in the direction of pathological or even lethal changes. Environmental changes, if applied to the early larval stages or to the egg itself, may be effective, though here again in the highest forms the result is usually pathological. Changes applied to the adult, may, however, affect the offspring, though not the parent. In such cases the effect of the altered environment is to produce in the egg only a comparatively slight structural change, yet sufficient to affect the actual constitution of the molecules of the chromosomes of the nucleus and, if this can be done without causing the death of the organism or a loss of the power of reproduction, the result is to produce something new and, if this change be transmitted to the progeny, then the result is the production of a new species.

To sum up all the evidence that I have put before you, it would appear that throughout the whole evolution of the animal kingdom, with the attainment of each higher stage there has been a loss of some power or function. The change from a non-cellular stage to that of a multicellular organism caused the loss of at least one function, namely, that of continuous reproduction, in all cells except those of the genital organs. Later on, the actual shape of the organism becomes more and more fixed and less and less susceptible to external changes, and development has to proceed along definite lines, a head forming at one end and a tail at the other, regardless of the position of the developing egg ; and all that can be achieved in the way of changes in the genital organs or the genital cells themselves, which still retain, in some degree and possibly to a considerable extent, the susceptibility to changes of environment that existed in the lower organisms in times past, is the production of comparatively insignificant variations in the more or less superficial characters or else changes of a pathological nature. There has thus been a gradual loss of plasticity. The lines along which an animal must normally develop, become more and more fixed and conversely the degree to which it can be affected gradually becomes less and less as we pass up the scale, while the period of existence in which an animal can be influenced is more and more limited and this limit is reached at a progressively earlier stage in its development. It would thus seem that, after all, the physicist may be right and that in the higher forms of life, including ourselves, we may be rapidly approaching the stage when further evolution is becoming impossible. If that be the case, then we are equally rapidly approaching the stage when, unless we have become completely superior to our environment and can ignore any and all changes in our external conditions, the existing higher animals and especially the human race will disappear from off the face of the earth to make way for some other form of life that has not as yet become restricted in its power of response.

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[1] Hyman, Libbie H., 1927. 'The Metabolic Gradients of Vertebrate Embryos.' III. 'The Chick.' *Biol. Bull.*, Vol. lii, No. 1.

(This paper includes a large number of references to the work of previous authors on the effects of abnormal conditions, such as X-rays, exposure to electric current, action of chemical vapours, e.g., alcohol, ammonia, ether, lack of oxygen, delayed incubation, and high or low temperatures, on the normal process of development.)

(*To be continued.*)

A SPIDER THAT CAN CHANGE THE COLOUR OF ITS EYES AT WILL.

(*MYRMARACHNE PLATALEOIDES,* Camb.)

BY

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(*With 4 plates and 4 text-figures.*)

Introduction

The following article is one of a series of studies I have been making regarding some of the local ant-mimicking spiders. In sending out these notes I have to acknowledge very gratefully the great help and encouragement extended to me by the Hon. Secretary, Bombay Natural History Society, and by the Director of the Zoological Survey of India, by advice regarding identifications, literature, etc. I also gratefully acknowledge the help given me by Dr. F. H. Gravely of the Madras Museum who first drew my attention to this interesting side of Spider life, and by my professor at the Presidency College, Madras, Rao Bahadur K. Ramunni Menon, under whom I learnt the pleasures of open air zoological study. To many others also I am deeply indebted: to Dr. Warburton, S. Kensington, who so kindly responded to certain queries of mine and gave me some valuable suggestions, to Miss E. C. Carrapiett, the lady Principal of this institution, who in many ways helped and encouraged me in this work, and to Mr. James Pryde, the Principal and Professor of Natural Science in the local Science College, who so kindly permitted me to use certain instruments in his laboratory.

Under the heading 'On the change of Colour in the eyes of an Attid Spider' a note was published in *Nature,* vol. 68, 1908, by Mr. T. Padmanabha Pillay, Trivandrum. He observed a small Attid Spider which could change the colour of its eye at will. Since then no further contribution on this peculiar phenomenon seems to have been made. In the following notes the present writer gives an account of his observation and studies on the eye peculiarity as seen in the spider *Myrmarachne plataleoides* from Travancore.

In the description of *M. plataleoides* by Peckham in the Occasional Papers of the Natural History Society of Wisconsin, 1889, where specimens from Ceylon are described, the eyes are all referred to as black. While this would be quite true to a casual observation of dead specimens, scrutiny of living ones shows that the case is not quite so. This was noticed while examining a number of these spiders which were kept in captivity. In a living individual the large anterior median eyes appear sometimes quite transparent or pearl-coloured and at other times quite black. The other eyes of this spider are all quite black. If these anterior median eyes are closely looked at for a few seconds the observer will be struck by a change in their apparent colour. These eyes change from dull whitish to black and from black to dull whitish. This change may be brought about rapidly or slowly. Sometimes both the eyes change colour alike; sometimes only one with the result that one eye is black and the other white at the same time. See fig. 8, plate III.

What can be the meaning of this white colouration for these eyes? Simon has suggested that the white eyes are for use at night and that the black ones may be diurnal. This, in this spider at any rate, cannot hold true for these spiders do not seem to be nocturnal at all. For the night they weave tiny silken retreats in which they rest. Even when disturbed they are very shy and quite unwilling to move about, which, were they nocturnal, they would not be.

A number of times, specimens of *M. plataleoides* have been observed at night in their retreats: they do not recognize the intruder's approach—in the day time it is almost impossible to avoid their noticing the intruder. On taking a needle to the front of the spider, and even on flourishing it in front of its eyes, it remains unaffected. Only on touching it with the needle does it 'awake' and run about wildly.

A specimen was kept in a small cage and occasionally fed on tiny insects. One night, after the spider had retreated into its nest, a small insect was introduced into the cage to see if the spider would attack it during the night, which could be expected if it were nocturnal. But the next morning the insect was found alive and the spider still at rest. An hour or so later the spider got out and was seen holding the insect in its jaws!

These and other observations of a like nature show conclusively that these spiders are not nocturnal at all. For an animal that is quite diurnal, to have the most important eyes, situated in the position of maximum efficiency and utility, adapted for vision at night seems quite unintelligent.

Observation of these spiders as they move about among the tree branches and leaves convinces one that their power of sight is quite keen. The slightest movement of anything in front, even at a distance of two or three feet, seems to arrest their attention. They immediately stop in their path and scrutinize. Often from the edge of a leaf or side of a twig, they can be seen watching the intruder with the forepart of their body raised high, to command a wider view. Under all such circumstances it will be seen that it is these frontal eyes that are always directed straight at the object looked at. And if one looks closely into these anterior eyes one will be able to observe the curious change in their colour which has been already referred to.

What does this change mean? Can it be that this spider converts its eyes from diurnal to nocturnal and nocturnal to diurnal at pleasure? But then, why this brisk transformation in clear daylight?

The apparent iridescence of these eyes when they 'show white' reminds one of the phenomenon of 'shining of the eyes', so marked in the eyes of certain animals; (e.g. the cat). In such eyes, inside the choroid there is a layer—the *tapetum lucidum*—which reflects the rays of light that fall on it and thus bring about the iridescent gleam. In the spider *M. plataleoides* however, this phenomenon does not appear to be brought about in this way.

As one observes the change of colour in the eyes of this spider one is reminded of the phenomenon of the movement of pigment in the compound eyes of the crustaceans in adjustment to the intensity of light. There it is observed that in bright light the pigment completely invests each ommatidium thus isolating it from its neighbours, while, in darkness these pigment blinds are withdrawn. No such movement of pigments however can be observed in this spider.

Examination of the top of the cephalothorax as the eyes are being 'rolled' as it were, by the spider shows two small black streaks, at a little distance behind the eyes, moving to and fro. The top of the cephalothorax in most specimens is opaque but occasionally a few specimens—probably recently moulted ones—are seen, in which this portion is quite translucent. In these, the black streaks in the front part of the cephalothorax behind the eyes can be very distinctly noticed, being moved to and fro when the eyes are changing colour. In fig. 1, pl. I is shown the cephalic part of the spider, as seen from the dorsal side under a lens : the black streaks that are moved to and fro when the apparent colour of the eyes change, are seen distinctly. Recently hatched young of these spiders were also examined : in them the cephalothorax was quite translucent and movements of the black streaks were noted very clearly. See fig. 2, plate I.

It was evident that these moving streaks inside the cephalothorax had something to do with the observed change in the colour of the eyes. On removing the cephalothoracic shield carefully, one finds inside two elongated cone-like structures attached to the anterior *median eyes.* [*Vide* figs. 3 (plate I) and 4 and 5, plate II.] The hinder halves of these 'cones' are black or deep blue, while in front they are white or translucent. These 'cones' are movable inside the cephalothorax, the broad end being fixed. The black streaks that are seen moving to and fro as the colour of the eye changes from white to black or *vice versa,* are really the hinder halves of these delicate cone-like structures, seen through the translucent cephalothoracic shield. Evidently then, these spiders can move these 'cones' inside the cephalothorax : and as the 'cones' are thus moved, the black or the translucent portion of the 'cone' may be brought in the line of sight of the observer, thus making the eyes appear black or white as the case may be. The accompanying diagrams explain the mode of working of these eyes. The first diagram shows a 'cone' not waved to a side but held straight behind. In this position, an observer who looks from the front straight into

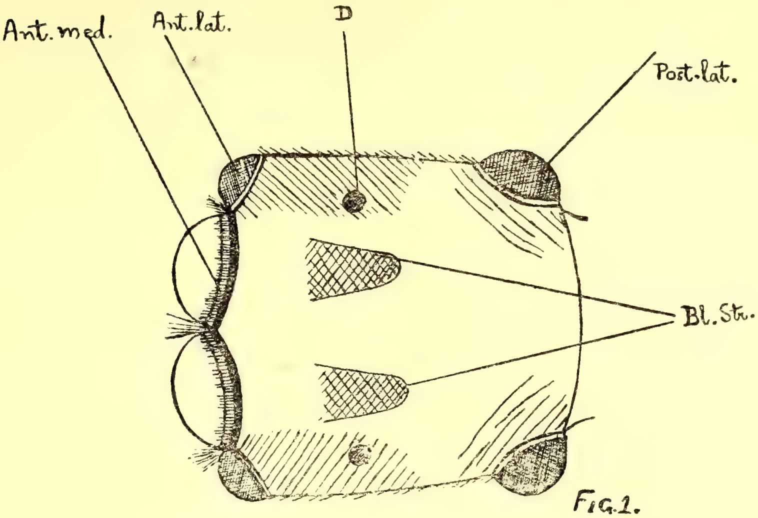

Ant. med.
Ant. lat.
D
Post. lat.
Bl. Str.

FIG. 1.

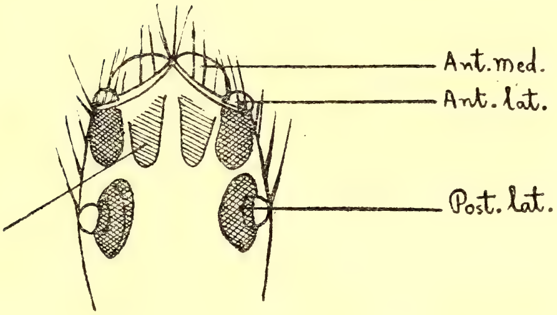

Ant. med.
Ant. lat.
Post. lat.

FIG. 2.

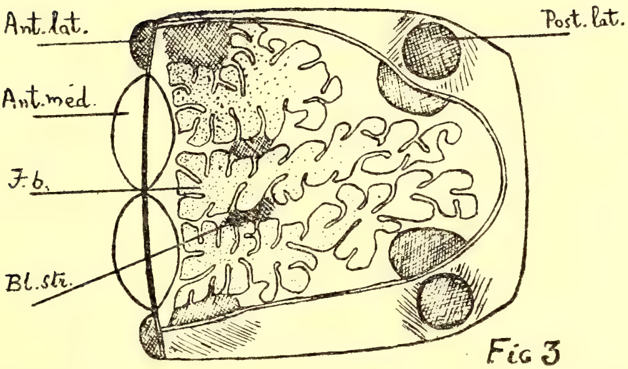
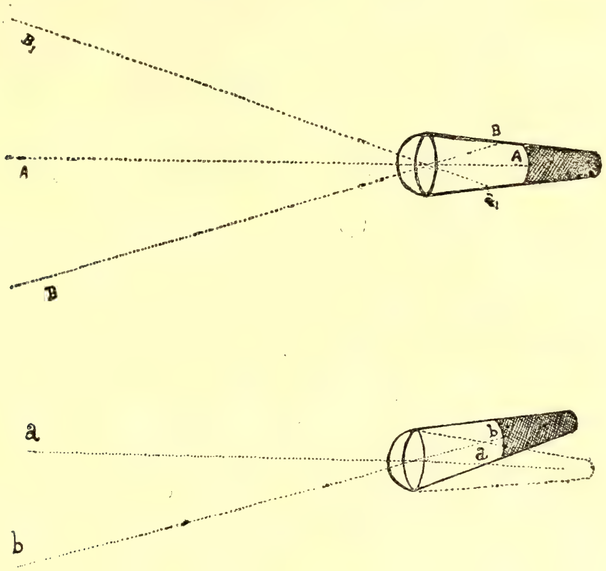

Ant. lat.
Post. lat.
Ant. med.
F. b.
Bl. str.

FIG 3

Change of Colour in the Eyes of the Spider *M. plataleoides*.
(*For Explanation of plate see end of article*).

the eyes, so that the line of sight is at right angles to the plane of the lens, will look into the depths of the 'cones' where they are jet black. He would see the eyes black (AA). If he shifted his position considerably to a side, his line of sight would strike, out at the black region of the 'cone' but only its anterior translucent portion : in consequence the eyes would appear whitish (BB and B^1 B^1).



TEXT FIG. 1.
Diagram to show the action of the 'cones'. For description see text.

The second diagram represents the 'cone' as it is waved inwards. In this position an observer from the front looking in such a way that the line of sight from his eyes strikes the lens at right angles to its plane, would be looking, not into the black part of the 'cone', but at the translucent anterior region and hence he would see the eye whitish (aa). If he shifts his position outwards to a certain extent, he would be looking into the depths of the 'cones' and thus the eyes would appear black (bb).

From what has been explained above it will be clear that *when an observer looks at the eyes from the front, they appear white or black according as the 'cones' are waved or not : and that the apparent colour of the eye at any particular time depends on the position of the cones and also on the position of the observer.*

The spider on which Mr. Padmanabha Pillay made similar observations was not identified and the account he gives of its appearance, while it does not give us any clue towards its identity, makes it clear that it was not *M. plataleoides.* What he says about the change of colour of the eyes in this spider may, however, be quoted as it is essentially in agreement with what I have observed in *M. plataleoides.* He says ' . . . when the spectator faces the eyes and the axes of the cones are parallel he sees into the depths of the cones and the eyes necessarily appear jet black. When the two tips of the cones converge the line of sight strikes the honey-coloured outer portion of the cones and then the eyes in consequence appear honey-coloured. Lastly, the spider has the power to cause the tip of only one cone to converge inward and then only that eye appears honey-coloured while the other remains black. . . . It must be well borne in mind that in all these cases the cornea of the eye remains perfectly unchanged and immobile, the change of colour being wholly and entirely due to the movement of the cones behind it.'[1]

By gently removing the top of the cephalothorax and the tissues lying just beneath it, the two 'cones' can be exposed (*vide* figs. 3, plate I and 4 and 5, plate II). The 'cones' then have the appearance shown in figs. 6 and 7, plate II, and differ in certain details from the cones described by Mr. Padmanabha Pillay. It would be seen that the 'cone' is not strictly a perfect cone. Its anterior portion, which is translucent, is widened forwards like a funnel and at the front extremity where it is widest, it is closely attached to the cuticular lens. This wide region passes behind into the black hinder part which is strongly compressed from side to side so that the apex of the 'cone' is not tapering but is distinctly flattened at the sides. This is noted quite clearly when the 'cones' are examined under a dissecting microscope. See side views, fig. 7A and B (Plate II).

Transverse sections of the 'cones' at different parts of its length are shown in figs. 10 and 11, plate IV; the section through the anterior region (fig. 10) is more or less circular while the section through the hinder region (fig. 11) is elliptical due to the lateral compression of this region. The translucent anterior region on closer examination is found to be not quite translucent uniformly all over but to have slight pigmentation dorsally—in some specimens almost quite dark—while ventrally and on the sides it remains quite clear. This dorsal pigmentation of the anterior region of the 'cone' is of considerable interest. It in a very simple way explains why the eyes when looked at from below always appear black and from above always whitish. In Mr. Pillay's spider, this behaviour is slightly different and he accounts for it in another way. 'When the line of sight from the observer's eye to the cornea is at right angles to the latter the eyes invariably appear honey-coloured. The reason is obvious, namely, that the line of sight strikes only the honey-coloured portion of the conical sac behind the eyes. Hence it follows that the axes of the cones must be either above or below the line of sight. But as a matter of fact, it is above it. The proof of this is that if you look at the eyes a little from below they appear black whereas if you look at them from above they still remain honey-coloured. The accompanying diagram demonstrates that this can only be the case if the cones lie on an inclined plane with the apices a little above the plane which divides the cornea horizontally into two equal halves.'

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[1] *Nature* 68, 1908,

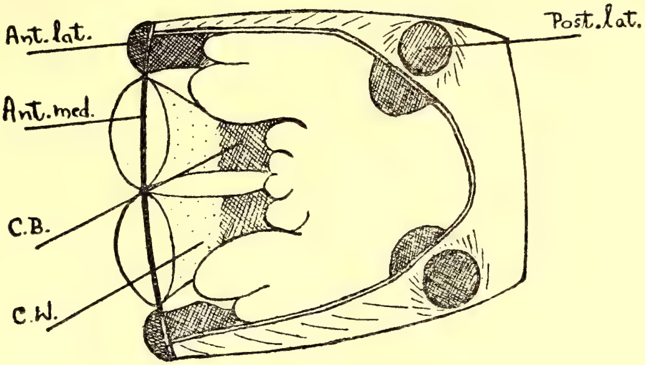

Ant. lat.
Ant. med.
C.B.
C.W.
Post. lat.

FIG. 4.

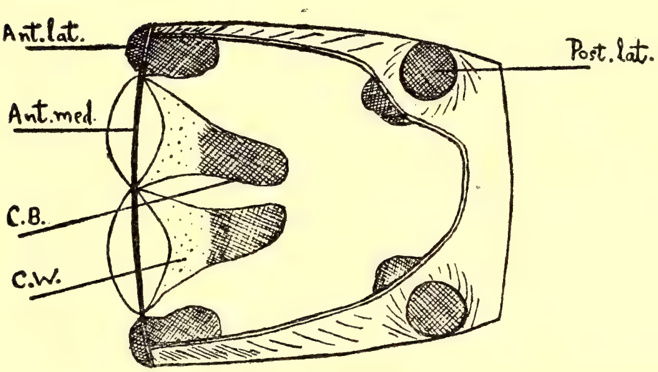

Ant. lat.
Ant. med.
C.B.
C.W.
Post. lat.

FIG. 5.

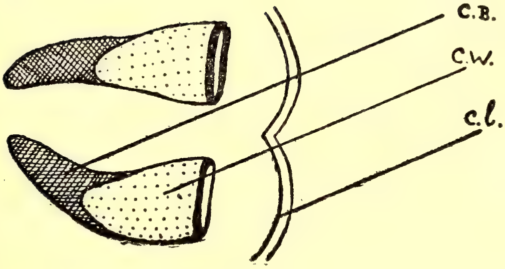


FIG. 6.

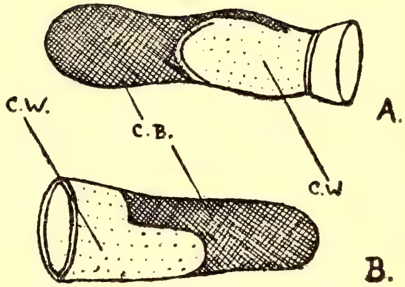
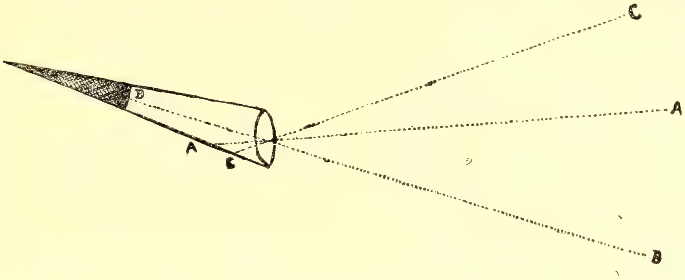


FIG. 7.

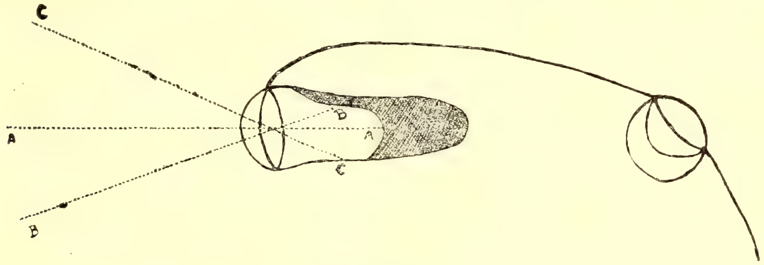
Change of Colour in the Eyes of the Spider *M. plataleoides*.
(*For Explanation of plate see end of article.*)

In *M. plataleoides,* however, the eyes, when looked at straight, horizontally from the front, i.e., 'when the line of sight from the observer's eye to the cornea is at right angles to the latter', show the characteristic change in colour from black to white and from white to black. Hence it will be obvious that here the 'cone' is not displaced above the horizontal plane as in the other spider. Even if a slight displacement existed it would not in this case produce the same effect, as the 'cone' here has the apex not tapering but elongated dorso-ventrally. Actual dissection of these 'cones' fails to show any appreciable displacement of these above the horizontal plane such as would make the eye appear white when looked at from the front. This would be evident from the diagram given below and also from fig. 9, plate IV, which represents a longitudinal section through the cephalothorax cutting parallel to the long axis of the anterior median eyes. The section is not de-pigmented so that the dark and clear regions are seen distinctly.



TEXT FIG. 2.

Diagram given in *Nature* 68, 1908, by Mr. Padmanabha Pillay. For explanation see the above quotation.



TEXT FIG. 3.

As there is no upward displacement of the free end of the 'cone' an observer looking at these eyes straight from the front look into the depths of the 'cones' (see diagram above) when these are not moved inwards, and so the eyes appear black (AA). If the 'cones' are converged the line of sight strikes the translucent outer portion of the 'cone' and hence the eyes appear white. But when looked at from below the eyes invariably appear dark. This clearly is due to the dorsal pigmentation of the anterior part of the 'cone': for in this position the line of sight (BB) would strike at this darkened region of the 'cone'. When looked at from above it appears white, for here the line of sight strikes the clear under-part of the 'cone' only (CC).

According to a suggestion of Dr. Warburton an attempt was made to discover whether this change of colour of the eyes had any relation to the distance of the objects looked at. But all observations seem to show that there is no relation between these. It was observed that this spider, whenever looking intently at any object far or near, or when disturbed, moves the cones of its eyes continually. When surveying an intruder standing about two or three feet away or admiring a lover at close proximity or in fierce hatred scrutinizing the body of an antagonist approaching it, under all these conditions, this spider was observed to 'roll' its eyes, sometimes very fast, sometimes quite slowly. When the change of colour is taking place leisurely a white streak can be observed traversing the cornea as the colour passes from one to the other. This certainly must be due to a narrow pale band that encircles the 'cone' in the region where it passes from the translucent to the dark.

A few stages in the gradual change of the colour of the eye, as one observes it from the front, are shown in fig. 8, plate III. On the left hand side a frontal view of the anterior median eyes is shown while on the right side the probable position taken by the 'cones' is indicated. A study of these diagrams shows clearly what happens in the anterior median eyes of these spiders. Figures A—E indicate that the movement of the 'cones' is mainly convergent i.e., the tips are brought together in the median line and then separated again. But the remaining diagrams seem to show that the movement is not so simple. Figs. F—G show that the 'cones' can be diverged to a certain extent while the last two figures suggest that there may be a slight twisting movement also. This last movement however has been observed only very rarely.

Though the structure of the anterior median eye with its 'cone' mechanism, appears quite strange, a comparison of this with a typical spider's eye shows that it is only an ordinary spider eye modified in certain details. Typically an anterior median eye of a spider[1] has a cuticular lens outside (monomeniscous)[2] which is continuous with the cuticle covering the body. Behind the lens is situated the ommateum. The ommateum is formed of two layers of cells. The outer layer which lies immediately in contact with the lens forms a mass of transparent cells—the vitreous body. Behind this is the retinal layer composed of the nerve-end cells having considerable pigment granules developed within them. The spider-eye (at least the anterior median) seems to be 'auto-chromic' i.e., there is no intrusive connective tissue bearing the pigment but it is all developed in the nerve-end cells themselves.

A glance at fig. 9, plate IV, will show that the plan of structure of the anterior median eyes in *M. plataleoides* is essentially the

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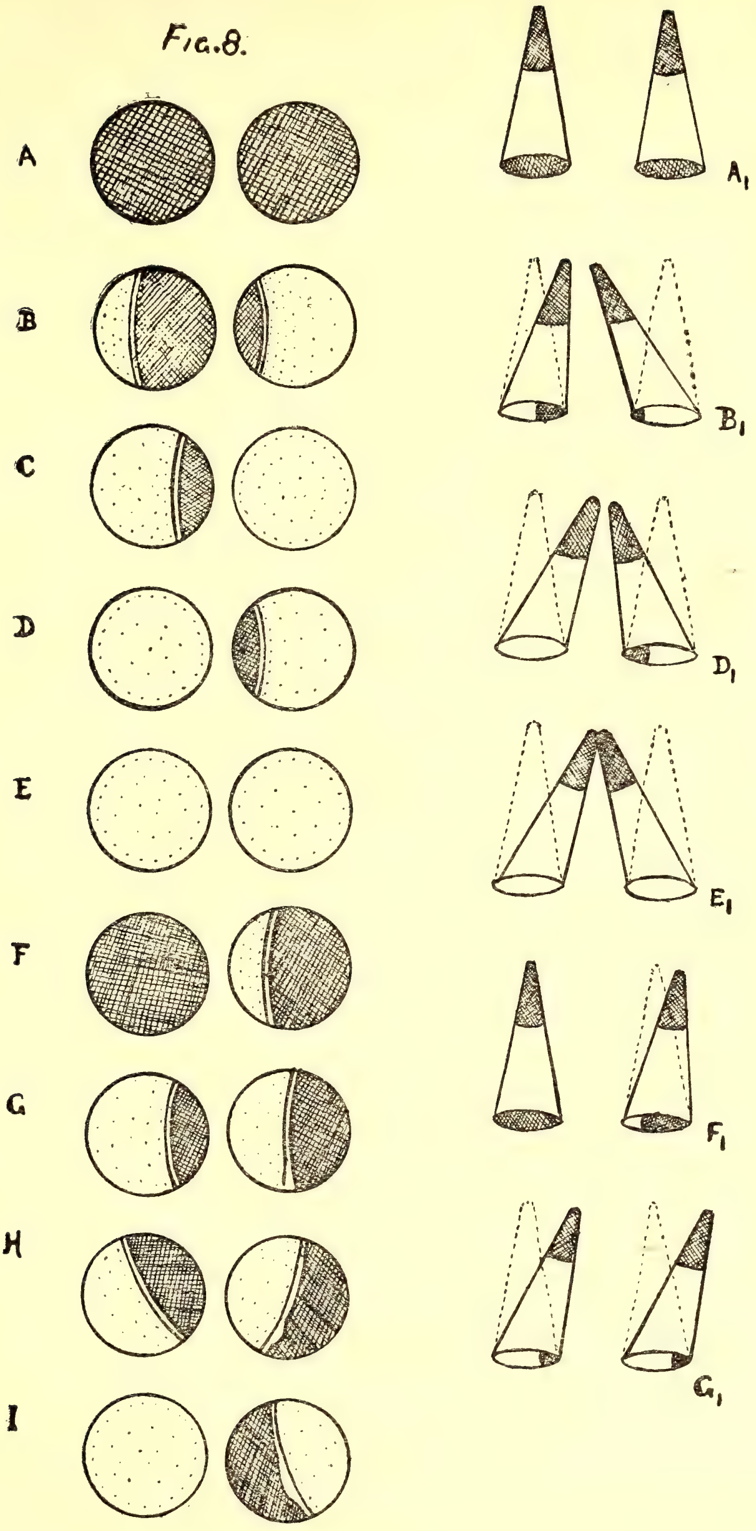
[1] In details of structure there are certain marked differences between the anterior median eyes and the other eyes of spiders.

[2] 'Unicorneal' of some authors but as Lankester and Bourne have shown 'monomeniscous' is a better term. *Vide Q.J.M.S.*, Vol. xxiii, 1883.

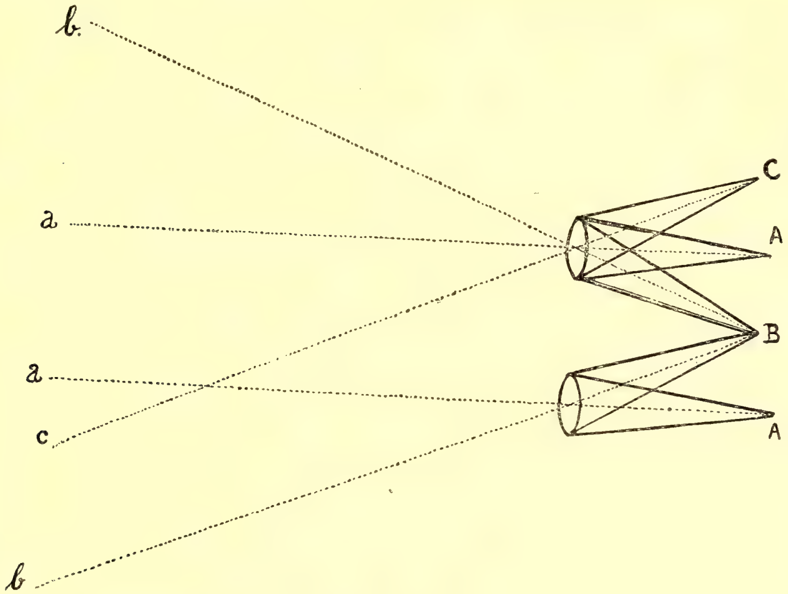
Fig. 8.


A
B
C
D
E
F
G
H
I
A_1
B_1
D_1
E_1
F_1
G_1

Change of Colour in the Eyes of the Spider *M. plataleoides*.
(*For Explanation of plate see end of article.*)

same.[1] The chitinous cuticle is thickened, forming the lens. Behind this are the clear enlarged hypodermis cells form the vitreous body. This however instead of forming a closed cup, as is usually the case, becomes elongated constituting the anterior translucent part of the 'cone'. *The 'cone' in fact is only the ommateum which is unusually elongated and made mobile.* The pigmented region formed of the retinal cells instead of forming a layer closely investing the vitreous body, gets elongated and withdrawn considerably backwards constituting the distal region of the cone-like structure extending behind the lens.

As the pigmented region is formed of the retina or the nerve-end cells, it is evident that the sensitive part of the eye is confined to the hinder black part of the 'cone' or ommateum. Hence, *when the 'cone' is moved the spider is actually bringing the sensitive part of the eye in line with the different parts of the field of vision, thus getting clearer view of them.* The diagram below demonstrates this :—



TEXT FIG. 4.

In the position AA, i.e., when the 'cones' are not moved, the spider will be seeing very clearly objects straight in front (aa) as images of these would be directly falling on the retina. By converging the 'cones' the range of vision can be considerably increased.

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[1] No attempt is made in this article to describe the minute structure of the eye. As the purpose of this paper is to investigate the observed change of colour of the eyes and as this phenomenon is dependent on the distribution of the pigment in the ommateum, the sections sketched are not completely depigmented. However, a study of the anatomy of these eyes of this spider and of others which show this same phenomenon would be quite interesting. It is hoped that this may be undertaken in another paper.

Thus in the position B, the field of distinct vision becomes much wider (bb), and the spider by moving the 'cones' to different extents may concentrate its attention on any particular part of this wide field.

Thus, by moving the 'cones' the spider can command a wider field of view. This particular phenomenon would then functionally correspond to the rolling of the eyeball by the muscles attached to it in the vertebrates and to the movements of the stalked eyes in some of the arthropods. But, while in the former the eye ball is moved and in the latter, the entire eye as a whole, in this spider the lens remains fixed and immobile while it is the ommateum that is moved directing the sensitive surface, the retina, at different angles.

Another probable significance of this phenomenon might be suggested. *M. plataleoides* is a perfect mimic of the Red Ant *Œcophylla smaragdina,* in close company with whose colonies these are met with. The body of the spider is elongated and constricted in such a manner as to resemble the ant's body very closely. The front part of the spider's cephalothorax is raised and rounded so as to suggest the ant's head. Of the four pairs of eyes on this cephalic region of the spider, the posterior laterals are black and answer to the large black compound eyes that are so conspicuous on the sides of the ant's head. As if the smaller size of the posterior lateral eyes in this spider might be an imperfection in its mimicry, a small region of the cuticle around these eyes is stained jet black. The dorsal and the anterior lateral eyes of this spider are too small to be conspicuous objects, but the anterior median eyes are very large and as they occupy the whole frontal area of the cephalothorax, if they have the normal black colour, they would form in the spider very conspicuous black marks which would have no counterparts in the models. But this inevitable blackening of the frontal area is avoided by having the black pigmented part of the eyes removed a considerable distance behind the lens in the way that has been explained above. By this arrangement *these large eyes are made to harmonize in colour with the general colour of the body and they do not stand out as very conspicuous objects.*

This view of the matter gains further interest due to the observation that this peculiarity of eye-structure is not confined to this species of ant-like spider but is found in certain others also. A number of species collected locally show this structure in their anterior median eyes, though the actual change of colour has not been observed in all of them. A dark brown and another quite black species, however, have been observed performing this curious feat. This is interesting. In the latter species the spider is black and the eyes too looked all black. After a few hours' patient observation it was obvious that this spider also 'rolled' its eyes in the same way as did *M. plataleoides :* but with this difference—when the black part of the 'cone' is in the line of sight of the observer the eyes are deep black as in the other type : but, when the 'cone' is moved a little so that the line of sight of the observer meets the translucent portion of the 'cone' the eye appears not honey-coloured as in *M. plataleoides* but dark, only not so deep as before. In fact, detection of this phenomenon would have been

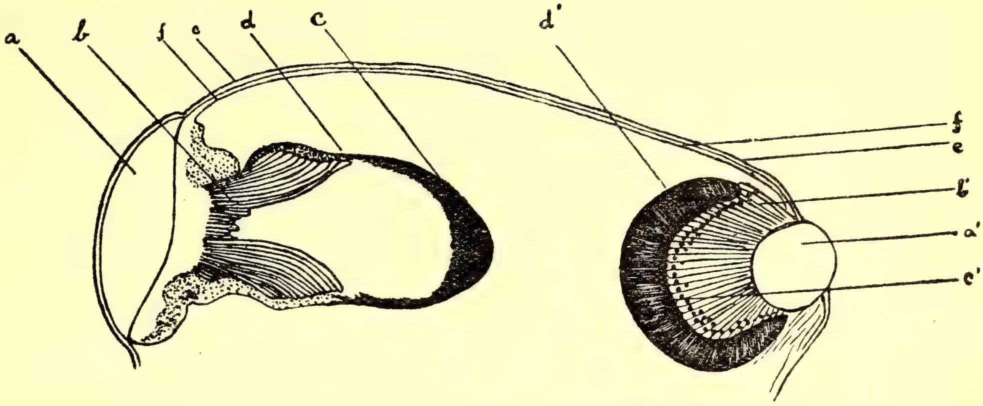
a
b
f
e
d
c
d'
f
e
b'
a'
c'

Fig. 9.

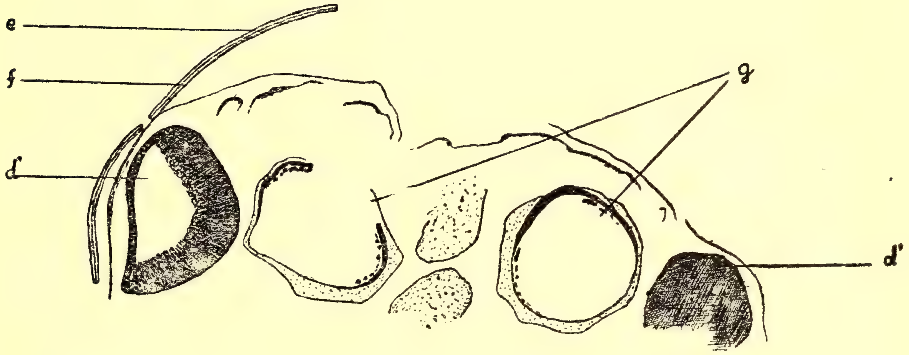

Fig. 10

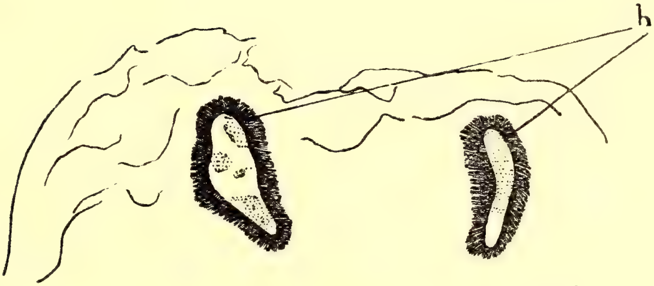

Fig. 11.

Change of Colour in the Eyes of the Spider *M. plataleoides*.
(*For Explanation of plate see end of article.*)

very difficult here, as no appreciable change in colour is produced when the 'cones' are moved, but for the fact that as the 'cone' is moved to and fro a clear streak can be observed crossing the lens. It might appear a little strange that a completely black spider should be provided with this mechanism : the whole spider is black and where can be the necessity for withdrawing the black pigmented part of the eye to the hinder end of a 'cone'? And why should there be the elaborate mechanism for waving of the 'cones' when this fails to produce any appreciable alteration in the colour of the eyes? And if this change of colour is brought about, would it not be meaningless here?

Confronted by this problem I was first inclined to suppose that this might be the general plan of structure for the anterior median eyes in ant-like *Attidæ*. Whatever be the colour of the mimic, the translucent front portion of the 'cone' ensures the obscuring of the otherwise too conspicuous black frontal eyes by approximating the colour of these to the colour of the body. This apparently would be unnecessary in the dark species : but when we recollect that many of these are lighter coloured and that the depth of colour is highly variable among these, the value of this provision would be obvious.

While studying this phenomenon, however, I came across a few other types of Attid spiders which showed this same mechanism in their anterior median eyes. These spiders show no striking ant-like features and cannot be referred to as ant-mimics. One of these is yellowish with greenish legs and it seemed that probably this was the spider on which Mr. Padmanabha Pillay made his observations of this phenomenon. But we cannot be definite about this as the description he gives is quite insufficient. These spiders show the phenomenon of the change of colour of the eye to a remarkable degree, the 'cones' being very well developed. I hope to give an account of these spiders which possess this 'cone' mechanism in their anterior median eyes in a subsequent paper. Here, however, this observation is of considerable interest since it shows that this phenomenon is not restricted to ant-like *Attidæ* but is found in certain others also. Hence we cannot hold that this peculiarity of the anterior median eyes is special to the ant-like *Attidæ* and that it exists for the purpose of obscuring the frontal blackening that may be caused by these eyes. At the same time we can safely maintain—for it is a matter of observation—that where this type of eye exists the inevitable frontal blackening is obscured. The withdrawing of the pigmented part of the eye to the hinder end of the 'cone' is not specially for the purpose of obscuring the otherwise too conspicuous frontal eyes : but when this type of eye-structure exists it produces this effect which may be of advantage under certain conditions. Thus, this obscuring may be of no special benefit in the non-ant-like spiders while in some of the ant-like forms it may be of some distinct advantage as suggested above.

SUMMARY.

1. The anterior median eyes or the principal eyes of Attid spiders are generally black while in certain species they have been observed to be white. In some of these species, however, it has been found

that these eyes cannot be strictly described as either black or white. Their colour has been observed to be always changing from one to the other during life so that at one time they may appear black, but the next instant they become white and then again black and so on.

2. It does not seem likely that the white colour of these eyes indicates their being nocturnal. The habits of some of the species showing this feature as well as the nature of the phenomenon seem to exclude any such possibility.

3. It is also not likely that this change of colour of the eyes has any relation to the distance of the objects looked at or to the intensity of the light.

4. The white colour is not produced by any movements of pigments themselves, or through a reflecting tapetum, but is caused by an internal mechanism. This consists of the ommateum which is elongated, the anterior region formed entirely of the clear vitreous body while the nerve-end cells containing the pigment granules are arranged behind. This elongated ommateum is freely mobile at the distal-end and when the spider moves it to different positions the eye may appear white or black according as the white or the black region of the ommateum is in the line of sight of the observer.

5. This movement of the ommateum may be of considerable advantage to the spider inasmuch as it widens its field of vision and enables it to concentrate its attention on any particular object.

6. In some of the ant-mimicking forms like *M. plataleoides* which mimics the Indian Red Ant, this may serve a secondary part, viz., the obscuring of the black patches in front (which might be disadvantageous in its successful mimicry) that would be caused by these eyes.

Note.—Since sending the above account, I had been making some further observations on this peculiar property of the anterior median eyes of spiders. A few more specimens of *Attidæ* were examined which showed this phenomenon. In some it could be ascertained only with considerable difficulty. A few specimens of *Thomisidæ* were also examined. In two species examined, the phenomenon could be distinguished quite clearly. In *Amycisea,* the small anterior median eyes had little 'cones' attached to them which were waved to and fro very briskly making these little eyes shine with a pearly lustre now and then, immediately returning to the dark colour. Thus this phenomenon appears to be not restricted to the *Attidæ,* but extending on to at least one more family.

EXPLANATION OF PLATES.

Plate I (Figs. 1-3)

Fig. 1. A dorsal view of the cephalic region of *M. plataleoides* showing the position of the eyes and the black streaks behind the anterior median eyes which are waved to and fro as the colour of the eyes change. Mag. about 40 times.

Fig. 2. A dorsal view of the cephalic region of a young *M. plataleoides,* recently hatched. The black streaks behind the anterior median eyes are clearly visible.

Fig. 3. Dissections of the cephalic region of *M. plataleoides* so as to show the 'cones' of the anterior median eyes. In Fig. 3, the cephalic shield is removed showing the underlying fat body between the ramifications of which the black streaks may be made out. Magnified about 40 times.

Ant. med.........................Anterior median eyes.
Ant. lat.........................Anterior lateral eyes.

Bl. Str.	The black streaks seen on a superficial view from above.
C. B.	The black hinder part of the 'cone' attached to the ant. med. eyes.
C. W.	The white anterior part of the 'cone' attached to the ant. median eyes.
D.	The dorsal eyes.
F. B.	The Fat-body.
Post. lat.	The posterior lateral eyes.

Plate II (Figs. 4, 5, 6 and 7).

Figs. 4 and 5. Dissection of the cephalic region of *M. plataleoides* so as to show the 'cones' of the anterior median eyes. In Fig. 4, the fat is removed and the 'cones' are partly exposed, partly covered over by the lobes of the brain. In Fig. 5, the brain also is removed thus exposing the two 'cones' completely. Magnified about 40 times.

Fig. 6. The 'cones' of the anterior median eyes as seen under the dissecting microscope after the removal of the cephalic shield and the tissues beneath.

Fig. 7. A & B. Side views of these 'cones'.

Plate III (Fig. 8).

Fig. 8. The anterior median eyes of *M. plateleoides* as seen when looked at from the front. The series of diagrams on the left hand side show the appearance of the eye as the colour changes. On the right side the corresponding position taken up by the 'cones' is represented. For example, A_1 represents the position of the 'cones' when the eyes are seen black as at A, while F_1 shows the position assumed by the 'cones' when the eyes appear white as at F.

C. B.	the black hinder region of the cone.
C. L.	the boundary of the cuticular lens.
C. W.	the translucent or 'white' anterior region of the cone.

Plate IV (Figs. 9, 10 and 11).

Fig. 9. A longitudinal vertical section through the cephalic region showing one of the anterior median eyes and a posterior lateral eye in section. The section does not pass through the median line of the anterior median eye but slightly to a side. The diagram was drawn from one of my slides with the help of a camera lucida. [Magnification—110 diam.]

Figs. 10 and 11. Transverse sections of the cephalic region passing through the 'cones' of the anterior median eyes. These diagrams were drawn from my slides with the help of a camera lucida. [Magnification × 110.]

Fig. 10. Section passing through the anterior region of the 'cone' which is clear and translucent.

Fig. 11. Section passing through the pigmented hinder region of the 'cone'.

a	The cuticular lens of the anterior median eye.
a^1	do. of the posterior lateral eye.
b	the clear cells making up the vitreous body: these form the translucent anterior part of the 'cone' of the anterior median eye.
b^1	the vitreous body of the posterior lateral eye.
c	the pigmented nerve-end cells forming the retina: these form the hinder part of the 'cone' in the anterior median eye.
c^1	the 'retina' of the posterior lateral eye.
d	the 'cone', i.e. the ommateum of the anterior median eye.
d^1	the ommateum of the posterior lateral eye.
e	the cuticle.
f	the hypodermis.
g	the 'cone' of the anterior median eye cut across in the clear anterior part. Note the circular outline and the dorsal pigmentation.
h	the hinder, pigmented region of the 'cone' cut across. Note the lateral compression and contrast with g.

THE ROLE OF SUNBIRDS AND FLOWER-PECKERS IN THE PROPAGATION AND DISTRIBUTION OF THE TREE-PARASITE, *LORANTHUS LONGIFLORUS* DEST., IN THE KONKAN (W. INDIA)

BY

SALIM A. ALI.

(*With 2 plates and 4 diagrams.*)

Even the most casual observer of Nature cannot but notice the ubiquitous clumps of the tree-parasite (*Loranthus*) with yellowish-green, rather long, oval-shaped leaves which infest the trees in such profusion in Western India and elsewhere throughout the country. Once it has secured root-hold, the parasite spreads from branch to branch with astounding rapidity, and unless removed in time it is not long ere the host is sucked dry and smothered to death. I have had special opportunities for studying the subject of the role of birds in the propagation of the species *L. longiflorus* Dest. during the past year. My observations have brought me to the conclusion that the life-history of the parasite is so inextricably linked up with the existence of Sunbirds and Flower-peckers that it would soon die out altogether without the intervention of the birds. Indeed it seems to me that the only effective way of eradicating the parasite lies in the extermination of the Sunbird, a vandalism, it is to be hoped however, no one will seriously take into his head to practice. 'Man cannot live by bread alone,' and the Sunbird is surely one of those etceteras that help to supplement bread for the sustenance of man. This symbiosis has brought about the most remarkable specialization in the flowers of *L. longiflorus*, which is now without doubt one of our most highly developed 'Bird-flowers' in India. And what is true of *Loranthus longiflorus* is likewise true of many other Indian species as well.

Hosts of the Loranthus.—In Western India, *L. longiflorus* is a serious menace to the mango, and in the mango-growing districts of Ratnagiri and North Konkan the damage it causes must run to thousands of rupees annually. In smaller numbers I have also found it affecting the following trees : *Zizyphus* sp., *Bombax malabaricum*, *Psidium guava*, *Thespesea populnea*, *Grewia* sp., *Ficus bengalensis*, and *Casuarina equisetifolia*, while at Roha, in the Kolaba district I noticed it parasiting on the Teak trees (*Tectona grandis*) in the reserved forests.[1]

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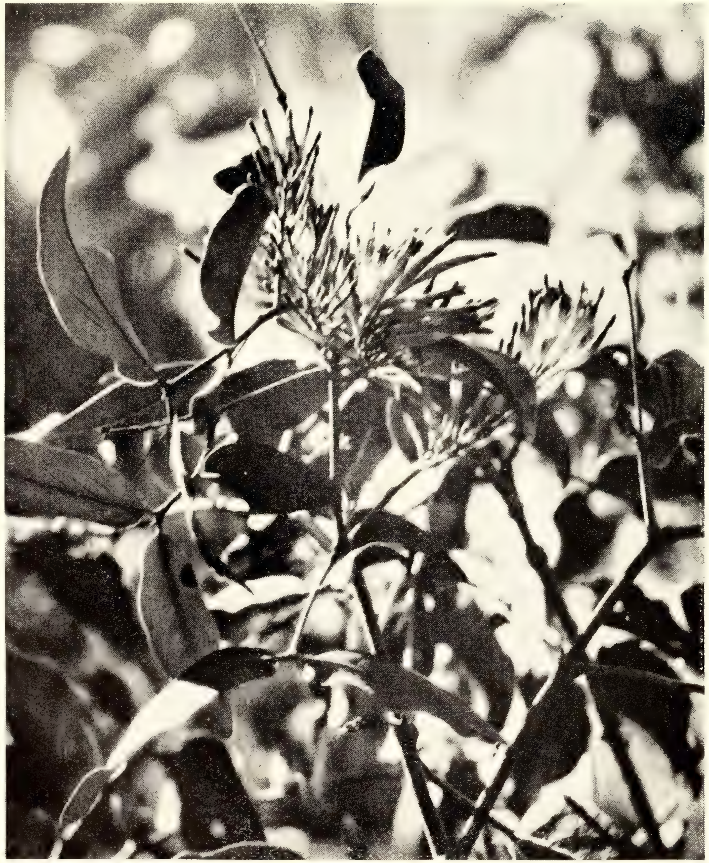
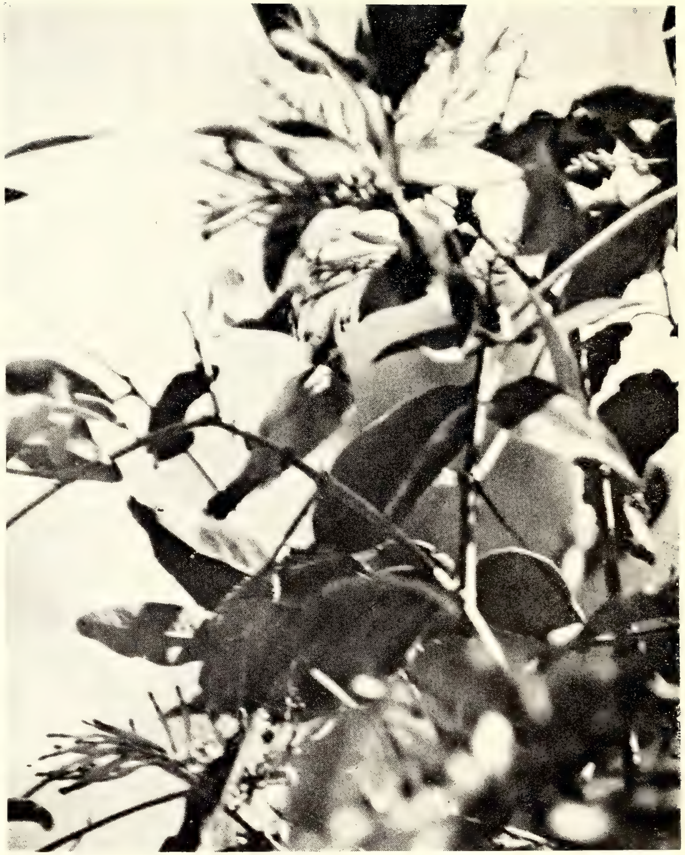
[1] Fischer records *L. longiflorus* from hosts of no less than 104 different species. If those of its varieties are added, the total number of specific hosts given by him is 153. (C. E. C. Fischer, 'Loranthaceæ of Southern India and their Host Plants.'—*Records of the Botanical Survey of India*, Vol. XI, No. 1.





Photos Salim A. Ali.

Loranthus longiflorus Desr. in bloom.

A Sunbird (*Leptocoma zeylonica*) probing into *L. longiflorus* flowers for nectar.

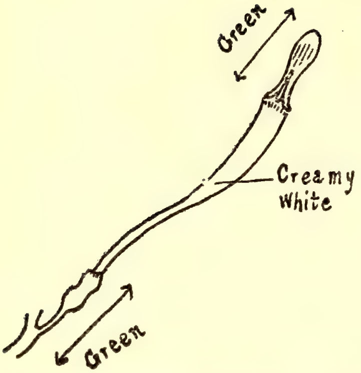

Green
Creamy White
Green

FIG. 1. Unopened Bud, *Loranthus longiflorus* Desr. Nat. Size.

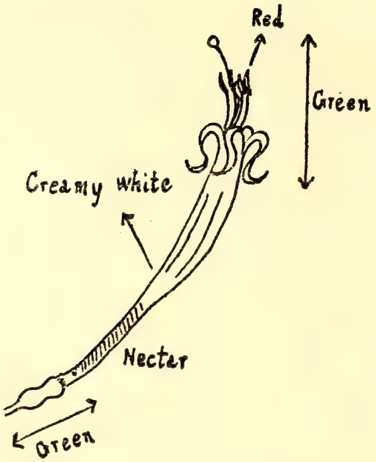

Red
Green
Creamy white
Nectar
Green

FIG. 2. Flower of *L. longiflorus*. Nat. Size.

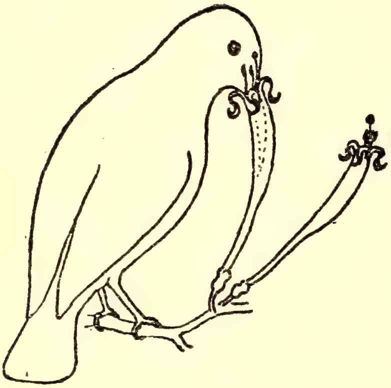


FIG. 3. Diagram of *Leptocoma zeylonica* feeding from *L. longiflorus* flowers. About ¾ Nat. Size.

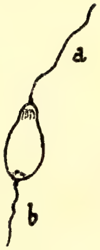


FIG. 4. Seed of *L. longiflorus* With adhesive filaments *a* and *b*. Nat. Size.

Flowering Season and Structure of Flowers.—*Loranthus longiflorus* flowers in every month of the year, but the period from mid-November to about the middle of January seems to be that of most abundant inflorescence. Every clump of Loranthus is one mass of blossoms at this season. The flowers are white with a faint tinge of cream or sometimes pink. They are about 4 cm. in length, thin, tubular and slightly curved. Their shape and size form, in the upper part, a perfectly fitting sheath for the bill of the Sunbird. The lower portion of the flower, where the tube narrows down (shaded in Fig. 2) contains the nectar, one to two drops of a colourless, watery, sweet liquid. The stamens, five in number, rise from the petals and are overtopped by the style which is green and terminates in a tiny swollen knob—the stigma—about the size of a pin's head. The anthers are so arranged that when the bill of a Sunbird is inserted into the flower, they cannot but come into direct contact with the bird's forehead. The five stamens separate on the intrusion of the bill and the anthers lie flat against the feathers, encircling the forehead (Fig. 3). The pollen—a golden yellow dust—readily comes off to the touch and adheres to the feathers. The style, extending beyond the stamens, is naturally the first to come into contact with the forehead feathers, and if the Sunbird has been visiting other flowers previously, the pollen is brushed on to the mature stigma which is thus fertilized. The flowers of *L. longiflorus* belong to the ornithophilous type named by E. Werth[1] 'Explosionsblumen' or Explosive Flowers. How perfectly their mechanism is adapted for pollination exclusively by Sunbirds and Flower-peckers is seen from the fact that the buds will remain closed unless and until the necessary extraneous pressure is exerted to fling them open. The Sunbird hops from one bunch of blossoms to another, gently squeezing the tops of the mature buds (Fig. 1) in his mandibles. The pressure causes the bud to spring open or 'explode' exposing the essential organs (as seen in Fig. 2). The bird immediately thrusts its bill into the flower, sucks up the honey by means of its specially adapted, extensile, tubular tongue and passes on to a second bud. The extent of his services in fertilizing the flowers is immense. I have frequently observed one probing into 8 or 10 flowers in less than a minute, and when it is remembered that the bird spends the greater portion of the day in flitting incessantly from clump to clump in the self-same quest, some estimate can be formed of its importance to the Loranthus. Doubts have been entertained in regard to the object of birds' visits to flowers being solely for the sake of the nectar, and even to-day some ornithologists are inclined to assume that the search of insects is the primary cause. In the case of the Loranthus there can be no such uncertainty as the peculiar structure of the flowers precludes the possibility of the presence of insect prey within the tubes until the buds have first been visited and thrown open by Sunbirds or Flower-peckers. Besides, considering the high nutritive value of sugar, there seems no reason for doubting that some birds may, in a state of nature, exist exclusively on a diet of nectar. Sunbirds have been kept healthy in captivity for weeks together purely on a syrup of sugar and water,[1] and it is difficult to conceive that the 'short cuts' by birds to the honey in the flowers of *Sesbania grandiflora* as described by Tiwary[2] and of the many other species noted in Java by Porsch[3] can be for any but this purpose. Birds may—and indeed often do—take in addition to the nectar, small insects if present on the flowers, but there can be no doubt that their visits to 'bird-flowers' are mainly in quest of the nectar. The numerous stomach examinations made by myself in the course of this enquiry, chiefly in the season of profusest flowering, on *Leptocoma lotenia*, *L. asiatica* and *L. zeylonica* confirm this.

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[1] E. Werth, 'Kurzer Überblick über die Gesamtfrage der Ornithophilie' Botanische Jahrbücher, 53, 1915.

Pollinating Agents.—In Western India (Konkan) the birds chiefly responsible for fertilizing Loranthus flowers are the Sunbirds, three of the commonest species being *Leptocoma lotenia*, *L. asiatica* and *L. zeylonica*, while occasionally Tickell's Flower-pecker (*Dicæum erythrorhynchum*) who visits the clumps principally to feed on the ripening berries, will also lend a hand. I have shot specimens of the last named from flower clusters with the pollen adhering to their foreheads. Their stomachs contained much nectar which also dripped freely from the bill when the birds were held up by their legs.

To satisfy myself that the flowers were really incapable of developing without the interference of the bird visitors, I covered a bunch of 21 buds with 12 × 12 mesh wire gauze on 5th December. By the 19th, all the buds had withered and fallen off without a single one setting seed, though at one stage in the interval they were so mature that the red on the dorsal side of the anthers was partly visible through the slits near the top between the unopened, spring-like petals. Later the experiment was repeated on a larger bunch with the same result which shows that the agency of flower-birds is indispensable for fertilization in this species. Evans[4] who tried similar experiments on two African species, *Loranthus kraussi* and *L. dregei*, also came to the same conclusion.

Dispersal and Propagation.—The berries which are oval in shape about 10–12 mm × 4–5 mm., with a minute concave cup at the apex, take about a fortnight to reach maturity, i.e., the stage when they become an attraction to the Flower-peckers. If allowed to ripen, they assume a beautiful rosy-red colour in about 20 days. It is not usual, however, to find fully ripe berries on the clumps as they are rarely allowed to remain long enough by the birds, and except when in the greatest profusion (in late January or February, as a result of the heavy winter flush) they are seldom met with in this condition. Usually by the time they have acquired a slightly yellowish tinge and even before—

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[1] Blanckenhorn, 'Naturwissenschaftl. Studien am Toten Meer', Berlin 1912. Mr. S. H. Prater of the Bombay Natural History Society also reared a young *Leptocoma zeylonica* on a diet of Golden Syrup mixed with water.

[2] Tiwary, N. K. 'A Note of the Short Cut by Birds to the Honey in *Sesbania grandiflora*' *Jour. of the Ind. Bot. Society*, 1926, 5, pp. 121–23.

[3] Porsch, Otto. 'Vogelblumenstudien I', Jahrbucher für wissenschaftl Botanik, 63, 1924, pp. 553–706.

[4] Evans, Maurice E., *Nature*, Vol. li, p. 235, Jan. 1895.

as soon as the outer pulp shows signs of softening—they are taken by the Flower-pecker. In every bunch of berries there are several with marks of the birds' beak upon them which have been tested and found unripe. The two common Flower-peckers in Western India which give the berries practically wholetime attention are: *Dicæum e. erythrorhynchum* and *Piprisoma a. agile.*

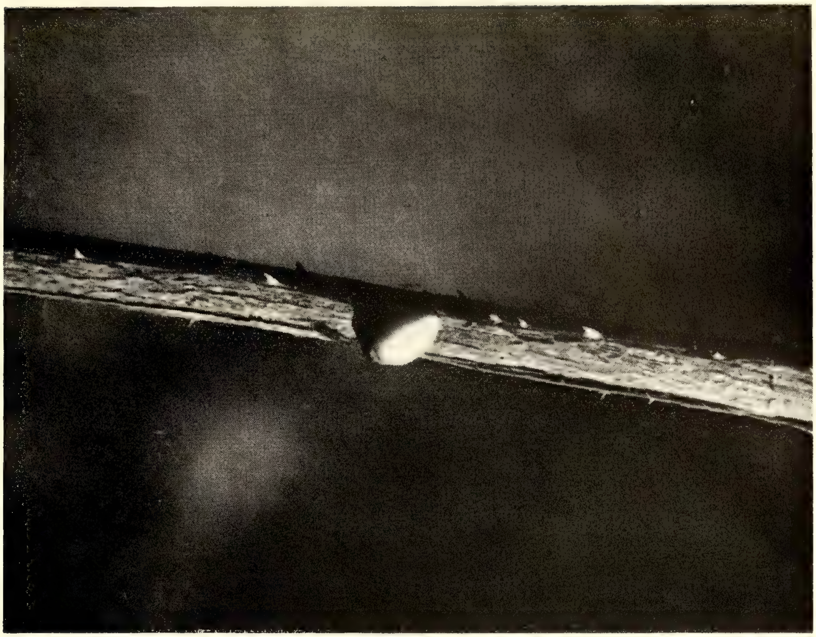
Tickell's Flower-pecker (*Dicæum e. erythrorhynchum*) in my opinion is undoubtedly the most important agent in the dispersal and propagation of the Loranthus parasite. I have studied their feeding habits and also examined the stomach contents of a great many specimens, shot in every month of the year, and find that while Loranthus berries are eaten whenever available, during the season when they are most plentiful they comprise practically the exclusive diet of this species. In addition to these, the other principal items of its food consist of the round, white berries of *Phyllanthus reticulatus*, an indigenous shrub, the berries of that pernicious imported weed *Lantana camara* which has now overrun and devastated thousands of square miles in India, and those of the 'Mistletoe' *Viscum articulatum* another tree parasite common in these parts on a species of wild *Grewia* and on the Ber (*Zizyphus*). Occasionally small spiders are also taken.

On the whole, its food and feeding habits constitute a serious indictment against the Flower-pecker. Lantana, Loranthus and Viscum are all highly injurious to forestry and arboriculture. All three (except the first whose berries are eaten and scattered by innumerable other birds as well) owe their propagation and existence more or less exclusively to this Flowerpecker and the next species. It has also been frequently accused of damaging ripe mangoes, a charge which my own observations have been unable to confirm. The Flowerpecker seems to have regular beats or feeding territories within which the individuals flit from one Loranthus clump to another at all hours of the day. While on a clump, the bird hops restlessly from bunch to bunch uttering an almost incessant *chik*, *chik*, *chik* which is occasionally varied by a series of twittering notes which might be termed its song. Each berry is first tested between the mandibles; if ripe it is plucked and swallowed, broad end (i.e. where the stalk attaches) first. After it has bolted down three or four berries, one after another the bird retires to the extremity of some bare branch at the top of the host or on an adjoining tree and sits quiet for a few moments with the feathers partly puffed out. It is during this interval that the mischief is done, for hardly has the bird been there a couple of minutes than you see him becoming uneasy, and presently one of the viscous seeds is excreted. I have often watched this process carefully through glasses. It appears to involve some effort on the part of the bird, which considering the size of the seed is by no means surprising. The passage of the seed through the intestinal canal and its exit through the anus is no doubt greatly facilitated by the extremely viscous substance in which it is invested. This is clearly evident when a slight pressure is exerted on the abdomen of a freshly killed specimen which very often causes a Loranthus seed to slip out of the vent. The seed is invariably extruded broad-end first—therefore, in the identical position in which it entered the food canal—and by a final jerky, and dipping motion of the posterior part of the body, during which the bird often pivots round from its normal crosswise position on the branch to one nearly along it, it is passed out. The extruded seed promptly adheres to the perch, slightly to one side of it as shown in the accompanying photograph taken soon after extrusion. (Plate II.)

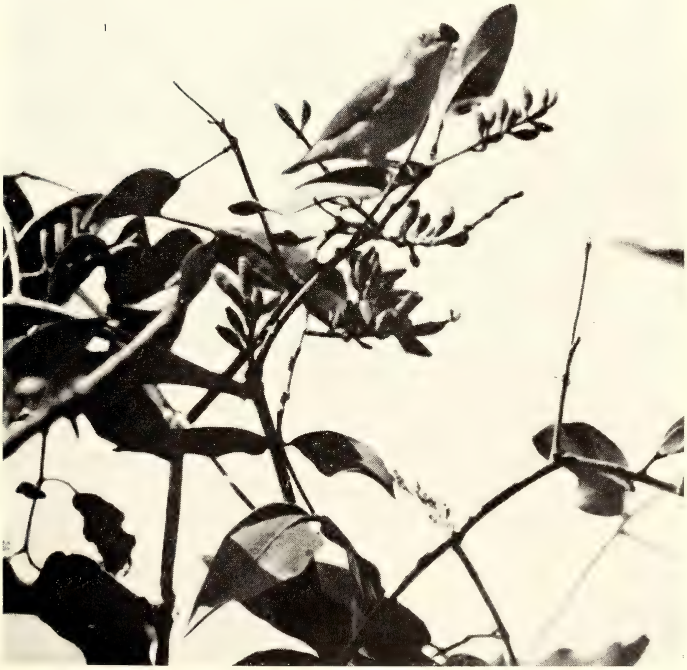
The discarded seeds measure on an average 10 × 4 mm. They are copiously covered with viscous matter and in addition have attached at the pointed end a sessile, thread-like, extremely viscid process about 22-25 mm. long. There is also a similar process on the broad-end which is much shorter, measuring about 10 mm. (Fig. 4). These processes resolve themselves into small sticky masses as soon as the seed comes in contact with a branch, helping it to secure its position.

The largest number of seeds taken by me from a single Dicæum is four. One of these was on the point of extrusion and partly out of the vent when the bird was shot. The other three were found in the intestine one behind the other, all with their broad ends in the direction of the vent. In birds the process of digestion is extremely rapid, but in the case of this Flower-pecker it seems to be exceptionally so. The seed probably does not occupy more than 3 or 4 minutes (perhaps even less) after the berry has been swallowed to pass out again. Time and again I have been able to watch the complete process from the swallowing of the berry to the extrusion of the seed, and as the inside of a Flowerpecker can obviously hold only a limited number of berries at a time—presumably not more than 4 or 5—my estimate cannot be far out. Immediately it has got rid of the unnecessary ballast, the bird flies off to some other clump uttering its lively *chik*, *chik*, *chik*. The normal method of feeding with Dicæum is to swallow the berries entire. Thus he is responsible not only for conveying the seeds to other branches of the same tree, but also for spreading them further afield to other trees in the neighbourhood. Occasionally I have also seen him pinch and revolve a berry in his finely serrated mandibles, stripping off the fleshy part and wiping the seed on to a nearby twig. This habit, however, is more common with the next species.

The Thick-billed Flower-pecker *Piprisoma agile agile* is also responsible for much mischief in the propagation of the Loranthus parasite, though the damage it does is no doubt considerably less. Examination of stomach contents and a study of its feeding habits shows that this species does not swallow the berries entire, except perhaps in very exceptional cases. The bird is in particular evidence on the Loranthus clumps between January and March when the berries are in greatest abundance. Like Dicæum, it flits about singly from one clump to another also appearing to have well defined feeding circuits. Its voice and notes are similar to those of the other species only perhaps somewhat shriller and more metallic; but with a little practice the two can easily be distinguished from one another. The bird twists its little tail from side to side as it searches amongst the clumps. The berry is plucked and invariably revolved between the mandibles which being thicker and stouter, appear better adapted to this method of eating. The flesh



Seed of *L. longiflorus* on a branch, photographed immediately on being excreted by *Dicæum erythrorhynchum.*



Photos Salim A. Ali.

A Thick-billed Flowerpecker (*Piprisoma agile*) with a berry of *L. longiflorus* in bill.

is soon detached and the seed wiped on to a neighbouring twig by a sweeping side-to-side motion of the head. Occasionally when disturbed at its meal the bird will fly off with a berry in its bill and this is the only way in which Piprisoma may spread the parasite to neighbouring trees. On a Loranthus clump on a Guava tree near my bungalow which I had under continuous observation, I found that while the berries were present, Piprisoma visited the cluster on an average about six times a day. Three or four berries were plucked on each of these visits, whose seeds were wiped on to the adjoining branches, with the result that within a short time there were hardly a couple of inches in a radius of about three feet of the clump free from the adhering seeds. It is on account of this feeding habit of Piprisoma that when lopping off branches affected by the Loranthus parasite care must be taken that all the adjacent members are likewise removed as these are sure to harbour some of the seeds.

In addition to Loranthus berries, the food of the Thick-billed Flowerpecker consists of a great variety of berries and fruits. Lantana is a favourite and here again the process of eating is the same as with Loranthus, the entire berries being rarely swallowed. It is therefore not responsible for scattering Lantana seeds far afield to the extent Dicæum is. Other contents of the stomachs I have examined were pulp of the Jamun fruit (*Eugenia jambolana*) and Peepai figs (*Ficus religiosa*) and also small spiders.

When one considers that these two species, which are by no means uncommon in these parts, are ceaselessly engaged throughout the day and month after month on their task of seed dissemination, one can form a fair idea of their power for evil to humanity and of their vital services to the plants on which they are in turn dependent.

SOME ASPECTS OF THE BIONOMICS OF THE LAC INSECT.

BY

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PROPORTION OF MALE TO FEMALE LARVÆ FOR EACH DAY OF EMERGENCE.

According to Sreenivasaya,[1] Mahdihassan says that the first batch of larvæ to swarm are mainly females, whilst those appearing later are chiefly males. This statement though vague, if correct would prove of great value in lac cultivation. Therefore, to test its accuracy, experiments with a number of individual cells were started in the Katki (July–November) crop in 1928 and repeated during the Baisakhi (November–July) 1928–29 and 1929–30 and the Katki 1929 crops. Each female cell was confined in a small wire gauze case and inoculated on a small plant of Ber (*Zizyphus jujuba*) or Arhar (*Cajanus indicus*). After each 24 hours of emergence the female cell was removed to the next plant, till the emergence of larvæ from the cell stopped.

The identification of sex in the first instar larva of the lac insect is a debatable matter, therefore to avoid controversial points, the inoculated plants were examined for the sex-ratio, only when the male insects had reached the prepupal and pupal stages. The results of these examinations are given in the following tables :—

KATKI 1928.

TABLE I.

COL. I. No. of cells out of the total 15, from which emergence took place on days stated in Col. II.	15	11	4	5	4	1	1
COL. II. Serial No. of days for which emergence continued in the number of cells stated in Col. I.	1	2	3	4	5	6	7
COL. III. Average percentage of females in the progeny of the cells stated in Col. I.	90·2	87·05	88·8	84·09	90·9	50	100

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[1] *Ind. Inst. Sc. J.*, Vol. vii, pt. vii, p. 110.

BAISAKHI 1928-29.

TABLE II.

COL. I. No. of cells out of the total 21 from which emergence took place on days stated in Col. II.	21	21	19	17	18	16	16	14	11	6	4	2	1
COL. II. Serial No. of days for which emergence continued in the number of cells stated in Col. I.	1	2	3	4	5	6	7	8	9	10	11	12	13
COL. III. Average percentage of females in the progeny of the cells stated in Col. I.	44·24	41·4	49·6	56·9	72·2	75·8	87·07	85·7	91·4	82·7	75·0	100	0

KATKI 1929.

TABLE III.

COL. I. No. of cells out of the total 15, from which emergence took place on days stated in Col. II.	15	14	14	13	9	9	10	6	3	1
COL. II. Serial No. of days for which emergence continued in the number of cells stated in Col. I.	1	2	3	4	5	6	7	8	9	10
COL. III. Average percentage of females in the progeny of the cells stated in Col. I.	94·9	84·09	81·4	79·5	91·4	78·9	93·2	79·3	100	100

BAISAKHI 1929–30.

TABLE IV.

COL. I. No. of cells out of the total 25, from which emergence took place on days stated in Col. II.	18	22	25	22	23	22	21	21	15	17	11	11	7	5	4	1
COL. II. Serial No. of days for which emergence continued in the number of cells stated in Col. I.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
COL. III. Average percentage of females in the progeny of the cells stated in Col. I.	63·49	38·03	40·76	45·19	50·18	71·18	74·61	72·22	63·95	85·39	82·02	92·00	88·88	69·23	82·14	50·00

The study of the above tables clearly shows that the statement made by Mahdihassan, that the first batch of larvæ which swarm are mostly females and those which appear later are chiefly males, is incorrect ; these results also show that the emergence of larvæ from the incubating chamber of the mother is of mixed character and that there is no inter-relation between sequence of emergence and sex ratio.

MOTHER CELLS AND SEX OF THE PROGENY.

In the course of the above study it has been found that :—

I. In the Katki crop (July–October) the progeny of most of the cells of the Baisakhi crop (October–July) develop as is already known into females predominantly ; but further it has been noted that the progeny of some of the cells develop into cent per cent females, and in a few cells, the progeny is intermediate between the two.

II. In the Baisakhi crop, the progeny of most of the cells of the Katki crop grow into predominantly female, of a few cells into predominantly male and of some, the progeny is intermediate between the two. Cells producing males and females from 40–60 per cent have been taken as producers of intermediate progeny regarding sex ratio. The results are tabulated below :—

KATKI CROPS 1928 AND 1929.

TABLE V.

—	No. of mother cells under observation	Mother cells whose progeny developed mostly into females.		Mother cells whose progeny developed into cent per cent females.		Mother cells whose progeny was intermediate.	
	—	No.	Percentage.	No.	Percentage.	No.	Percentage.
	23	17	73·91	5	21·73	1	4·34
Percentage of females in the progeny of these mothers.	81·2	80·08		100		53·9	

BAISAKHI CROP 1928–29 AND 1929–30.

TABLE VI.

—	No. of mother cells under observation.	Mother cells whose progeny developed mostly into females.		Mother cells whose progeny developed mostly into males.		Mother cells whose progeny was intermediate.	
	—	No.	Percentage.	No.	Percentage.	No.	Percentage.
	41	24	58·53	5	12·18	12	39·26
Percentage of females in the progeny of these mothers.	63·5	74·6		33·2		51·1	

SWARMING PERIOD.

The number of days over which the emergence of larvæ continues from an individual mother, depends, firstly on the temperature, secondly on the egg-laying capacity of the mother, and thirdly on the rate of egg laying. However, from the daily observations on 31 cells during July inoculations in 1928 and 1929 it has been found that:—

11 days is the maximum period for the emergence of larvæ from an individual mother and 6 days is the average period: while in the October-November inoculation observations on 50 cells show that 16 days is the maximum period for emergence to last from an individual mother and 7 days is the average period. The periods of emergence during the month of February are almost the same as those in October-November provided that the day temperature does not fall below the temperature at which the emergence started. It is also interesting to note that the largest number of larvæ swarming on a single day generally emerge from an individual cell in each crop season between the first and the fifth day of the swarming period.

CHOICE OF BROOD LAC.

Out of 51 apparently healthy mother cells during July inoculations in 1928 and 1929, larvæ failed to emerge from 20 cells. During October-November inoculations the emergence failed from 18 apparently healthy cells out of 68. On examination, dead larvæ in large numbers were found in the incubating chamber of most of the cells. The death of the larvæ in most of these cases proved to be due to the blocking of the anal openings of the lac tests through which the larvæ come out. In the remainder, the female was found to be attacked either by young predator larvæ which seem to have entered the tests through the anal opening, or by full grown parasite grubs. Besides this numerous cases have been noticed in which a mother though apparently quite healthy, for some unknown reason, fails to lay eggs, and consequently no emergence of larvæ takes place. In view of these facts, presumably the best brood for infecting, in cases where available, is one in which the healthy cells are situated closely but separately on the sticks or without much overlapping. This being preferable to brood which has a healthy looking thick incrustation due to excessive overlapping and coalescence of lac tests, because in the latter case there are bound to be a large number of dead and parasitized cells, and also a large number of cells which though living, have the anal openings of their tests blocked, by the neighbouring cells which coalesce and overlap them. This has been further confirmed by numerous observations during the examination of sticks for emergence, etc.

EGG-LAYING PERIOD.

As egg laying is the preliminary stage to the emergence of larvæ, it has been thought advisable to include some results in this connection, obtained from the data collected on fertility in the various broods, and on the effect of temperature and humidity on egg laying. The egg laying period depends like the emergence period, on the temperature during the swarming season, on the vitality of the mother, and on the number of eggs a mother is going to lay. Egg laying will begin in all the three seasons (June-July, October-November, January-February) if the temperature is above 17°C. In winter however it sometimes begins even at 15-16°C. The average egg laying period for an individual mother in all the broods during all the seasons is about 7 days and the maximum about 14 days. The largest number of eggs laid by a mother on a single day is generally laid between the 2nd and 6th day of the egg laying period.

ACKNOWLEDGMENT.

The Authors thanks are due to Dr. C. F. C. Beeson, Forest Entomologist, Dehra Dun, for valuable advice and criticism, and to Mr. P. M. Glover, Entomologist at the Indian Lac Research Institute for advice and correction of the manuscript.

CONCLUSION.

(1) Sequence of emergence and sex-ratio can hardly be said to be interrelated.

(2) The Baisakhi crop produces females whose progeny in the majority of cases is predominantly female, in some cent per cent female and in a few intermediate between the two.

The Katki crop produces a major number of females whose progeny is predominantly female, a few whose progeny is predominantly male and some whose progeny is intermediate between the two.

(3) Emergence (swarming) period depends on the temperature, egg laying capacity of the mother and rate of egg laying, 11 days seems to be the maximum swarming period for an individual Baisakhi mother cell, and the average period 6 days: for a Katki mother cell 16 days seems to be the maximum swarming period and 7 days the average. The largest number of larvæ swarming on a single day from a mother cell in all the seasons emerge generally between the 1st and 5th day of the swarming period.

(4) The average egg laying period for an individual cell in all the seasons is about 7 days and the maximum is about 14 days. A mother lays the largest number of eggs in a single day between the 2nd and 6th day of her egg laying period.

(5) The best brood lac is that in which healthy cells are situated closely but separately on the stick or are coalesced without much overlapping.

IN A BURMESE JUNGLE

BY

LT.-COL. R. W. BURTON, I.A.R.O. (Retd.)

Rangoon has altered out of almost all recognition since I last saw it in 1891. The golden dome and glittering spire of the Shwe Dagon Pagoda is, as formerly, the most conspicuous object in the landscape as the steamer slowly makes its tortuous approach to the landing stage ; but the piles of many stately buildings seem to my eyes to be almost all of them edifices constructed within the past forty years ; however one can forget quite a lot in close upon four decades !

The tramways and the motor traffic ; the tarmac roads ; the fine wide streets ; the numerous roadside stalls ; are all the outcome of modern development. The streets are thronged with people of all the nations of the East, and gaily painted rickshaws are busily plying in and out among the rapid traffic of the broad roads. The untidy litter scattered all around the street stalls is an offence to the eye, but one's nostrils are not assailed by the many offensive odours of the cities of India. The climate of Rangoon in mid-December is not unpleasant, but even then electric fans are always welcome during most of the daylight hours.

We left the central station next evening at six o'clock, and passing Pegu a couple of hours later, saw on our left the blaze of electric lights which outline the Pagoda and give it the appearance of an enormous Christmas cake. At four in the morning we found ourselves making tea on the platform of Pyinmana junction ; and soon after six o'clock were enjoying the scenery of the dense forests of the ' wet zone ' as the train wound its way over the lower elevations of the Pegu Yomahs.

The change in the vegetation showed us that we were gradually passing into the ' dry zone ', where the rainfall is but 20 to 40 inches as compared with the 60 to 100 of the other, and at twelve o'clock we arrived at Taungdwingyi.

T.G.I., as it is commonly styled for sake of brevity, was for some years the terminus of the railway in this direction, but the line has now been extended, and will eventually join the Thazi-Myingyan branch at the latter place.

Having stayed a day to purchase some local supplies, we next morning went about ten miles by rail, and seven by road, to a forest rest-house. The Forest Range Officer accompanied us and I rode one of his ponies. Both the animals were in beautiful condition and very spirited. The grey cost Rs. 275 and the bay Rs. 180, the former being about 14 hands in height. Our baggage was carried in carts, and I learnt that a cart complete with bullocks cost Rs. 350.

One of the first things which attracted my attention was the splendid condition of the draught cattle, and their untwisted tails, so different to the cruelly distorted appendages of the cattle of India. Ramaswamy, our Rangoon servant, admits that the undamaged tail is good, but says ' Burman's plenty much beating to make go '; but I noticed that any beating necessary is done with a pliant bamboo and not a rib-roasting cudgel !

Nearing our night's destination we passed the local monastery, situated on rising ground amid umbrageous trees, for these institutions are always established at the most favourable site to be found, and so arrived at the rest-house, a conspicuous building on posts, and forty feet square, the floor level being some ten feet above ground level. The accommodation is two rooms and bath rooms, with a verandah 36 ft. by 16 ft. Overlooking the large village of 80 houses just below us, we had a wide view over the surrounding country. All is forest as far as the eye can see, and away to the north and east are the Yomahs, covered with jungle throughout their length.

In the morning an early start was made to complete the seven more miles to the shooting camp, where there is a small forest village and a rest-house of similar size to that we had just left. The forest was, so far, very similar to that of the Central Provinces of India, and the birds and butterflies seen along the way were apparently of similar species to those of the same tracts.

The object of this trip was to obtain specimens of a bull *saing* and a stag *thamin*. The former is the wild ox of Burma and the Malay States, the latter the Brow-Antlered deer of Burma. For the *thamin*, search had to be made near the village just left ; and as there was said to be only one shootable stag, the quest was likely to be somewhat difficult.

On the morning of the 22nd December (1929), I set out before dawn with two trackers : directly overhead was the Great Bear, and the Southern Cross was among the tree tops. Behind us followed a lad, with our requirements for the day slung at either end of a bamboo carried over his shoulder. It was wonderful how silently he kept us in sight throughout our wanderings. The elder tracker was a middle-aged man of the rather womanish type, with gentle expression, of so many Burmans. He wore his hair long, and done up into a bun twisted together on top of his head. In his hand he carried a *dah* with a razor-edged blade about two feet in length, with which he often silently sliced off obstructing twigs and bamboo shoots. None of the jungle Burmese ; men, women, or children, leave their houses without a *dah*. As soon as a child can toddle, it carries a *dah*, and I used to see a mother and child going to the jungle for bamboos or what not, the infant with a *dah* as high as itself !

The younger tracker was a finely built fellow with splendid shoulders. He wore his hair short-cropped, as do so many Burmans of the present day, and had a drooping moustache of the Malay type. The elder man was clean shaved.

About two miles from the village we entered a network of ravines. There were some level places here and there, covered with dense vegetation and bamboo jungle interspersed with giant trees, some of the semal (*Bombax malabaricum*) trees being of immense size. Tracks of *saing* were soon found, and by seven o'clock we came up with a small herd. A cow dashed off from behind a clump of bamboos, and then came the loud snort of the bull which was some distance further on. We saw no more of the beasts, for the dry leaves and unburnt vegetation made silent passage through the forest most difficult. And the watching animal sees all the moves of the game ! But I was not unduly discouraged because I knew of this before starting, and that should fortune not favour me, there would be the almost certainty of success in May-June when proper tracking would be possible.

The next two days were blank, and Christmas Day was spent in camp. On the 26th the fresh tracks of a bull were found in a ravine at the foot of the hills. Following up, we eventually came on the animal. The trackers knew, long before I did, that we were close upon the bull : how I cannot say, as I could not talk to them and all our intercourse was by means of sign language ; I think it was that their ears were sharper than mine. A most prodigious snort, which had a metallic note and something of menace in it, announced that our approach was not undetected. Here my entire want of knowledge of the habits of this animal led me to suppose that the snort was followed by retreat and I went ahead as fast as I could, so giving myself away to the waiting and watching eyes which had the advantage of my seeking ones.

So all the view I got was of a yellowish-brown body as the beast turned and dashed away through the bamboos up the hillside. The horns I did not see, and consoled myself with the reflection that the bull was probably not the typical *old* animal I was in search of as a museum specimen. Anyhow he was too sharp for me !

Another day we got up to a bull which could have been shot, but was allowed to go as his horns had not been seen, and he also showed no white markings. I had read, in a book on sports in Burma that all old bulls have white markings amid the general khaki colouring but discovered by observation of mature bulls in the Ridowing sanctuary that this was not the case. On two days, cows were watched at close quarters. It was most interesting to see the fine animals, all unaware of my being so close to them, and admire their beautifully groomed bright chestnut coats, and white stockings. When a cow at last detected my over-confident peepings and peerings, the field glasses showed the slight raising of her muzzle when she snorted at me. And by this and other occasions it was learnt that there is always a considerable time between snort and departure, and that when the danger has been seen, or the approach heard from some distance, there is no snort, only a silent vanishing.

In many places were tracks of bison, elephant, and sambur ; and one day the fresh tracks of a prowling tiger. In some of the ravines were pools of water, all rapidly drying up, and from one of these the younger tracker speedily extracted a dozen murrel of the small variety (*Ophiocephalus gachua*) by means of a bamboo, and a hook produced from the recesses of his clothing. The bait was found under the boulders of the stream in the form of water crickets.

By the teaching of the Buddhist religion an unpleasant punishment awaits the hunter and the fisherman in their next existence ; and for them there is no possible salvation. The miserable destroyer of animal life dangles by the tongue on a fish-hook, while demons jerk him into the air, and drop him back into a lake of burning pitch! A bad look-out for myself and the young tracker.

At one time or another I have seen and killed snakes of all the four species deadly to man—Cobra, Daboia, Krait, and Saw-scaled Viper—but the King Cobra, the dreaded Hamadryad, I had never seen.

On the 5th January, when coming at midday down the open sandy bed of a ravine, in which were scattered pools of water, the leading tracker, rounding a bend a couple of paces before me, stood and pointed with his dah. There, right in the open, was a large black snake in the act of mouthing a big frog—a very giant of a frog—preparatory to swallowing it. He was quite unaware of our presence just 24 feet from it, and as we watched, threw out the latter half of his splendid form with one graceful sweeping curve so that it lay directly facing us, and fully extended. Its length was about 12 feet, its colour jet black, and its mouth—into the widely extended jaws of which I looked with my binoculars—was terracotta, the same colour as a tiger's nose. There was a slight whitish marking on its neck which I took to be on the flattened hood.

I had signed to the men behind me not to move, as there was every prospect of seeing the brute get outside its tiffin, but one of them did so, and in a moment up went its head, its eyes glistened as it saw us, and it turned to go up the bank into the forest. I could have taken my rifle from the man behind me and shot it in the neck in the first instance, but was too interested to think of it. Now it was too late. He seemed to just stand on his tail and go up the twelve-foot bank without any effort. Its head went into the hollow of a tree and emerged on the further side. Then his sinuous form made its way parallel to us, along the top of the bank, and disappeared from view. It was about twelve inches or more in girth at the thickest part. Had the snake attacked us, as the species has the reputation of doing, there is no doubt that the keen-edged dah would have sliced it in two as if it were one of the green bamboos which the tracker, practised from his infancy in the use of the weapon, severed every day of his life with just a flick of his wrist. Without such a weapon, or a shot gun, one would be indeed without defence against the attack of the hamadryad. It passed through my mind that one's best defence would be to offer one's sola topee to its gaping jaws and then make the best side exit possible! A blow from a walking stick such as I had in my hand would probably not have baulked the 'spot stroke'. Alas! My camera was out of order, the orange celluloid disc having dropped out.

From the appearance of the inhabitants of this forest village it was evident that they suffered much from malaria, so I was not surprised one day to find myself down with fever. It was a short attack of five days only, and in the intervals there was time to admire the view from the verandah.

Below was a field of millet, bright green but tending to a commencement of ripening. In it was a platform from which, shaded from the sun by a sloping roof of bamboo matting, a boy rattled a tin and pulled strings connected at different parts of the field to loud sounding wooden clappers. His job was to frighten away parrots, and other birds, eager for the coming grain. Beyond the field was a wide belt of feathery bamboos which were daily losing the brilliant green of the rainy season ; and stretching away to the hills is the forest of all shades of green and of brown autumn tints. The teak trees were rapidly becoming destitute of all leaves, but in the ravines and hollows the moisture kept the tree tops green.

The hills have an undulating outline and reach an elevation in places of over 2000 feet. They are wholly covered with forest, the spurs and the ravines being clearly defined by the colour of the foliage. I gazed at the dark places and wondered what beasts were harbouring in them.

In the evening the light softened and the scene was one of wondrous beauty and charm. One listened to the twittering of birds, the sweet whistling note of the green pigeons and screech of parrots, the loud call of the tauk-teh lizard ; and from the hamlet came the merry voices of the careless, laughter-loving Burmese women taking their rest after the usual day of toil which is their lot in life. Now they were adorning themselves, combing their hair and powdering their faces. One evening I came upon a bevy of them sitting on stones jutting out of the water in the stream all merry and laughing and looking neat and pretty ; though not so tidy or so clean as their sisters in the large villages. This is a jungle hamlet ; just a forest village of a dozen houses, built on posts as is the fashion of this country.

Beneath the houses are the cattle and the dogs ; the ducks and fowls ; the carts and the farming implements ; and in the evenings, around the smoking wood fires, are the slanty-eyed little children, solemnly warming themselves in the chilly air : for the temperature falls rapidly after sundown at this time of the year, being as low as 50 ° before sunrise and as high as 85° in the middle of the day.

After the bout of fever another day or so was spent in roaming the forests from earliest dawn to late in the evening in vain search of the bull *saing*, and then I realized that hoping for a lucky chance would be of no avail and further efforts must await the onset of the rainy season.

Back to the first village we went, passing through patches of charred jungle, for the forest fires had commenced and in all directions could be seen a pall of smoke. The bungalow had suffered slight damage from the earthquake which had roused us at midnight a week before at our last camp : the doors and windows would not close and the posts were about four inches out of plumb. At night, from the verandah, long lines of light could be seen, with here and there huge beacons of leaping flames where the hungry fire had found dense patches of grass and dry bamboo. All this was strange to see after being so long used to the strict fire protection in force in India. It seems that the policy of fire protection was abandoned in Burma some years ago, much to the relief of the jungle people no doubt, and it was with evident delight that the men with me used to expend the best part of a box of matches during the day in the forest.

On the first morning at the new camp I had a glimpse of the solitary stag *thamin*: seeing that he carried a good head and was very dark in colour: and that was all that was seen of him in five days' search! A more cunning and elusive beast I never hunted. So it was exactly a month after entering the jungles that I left them without either of the animals which I had come so far to get.

Having returned to Taungdwingyi, I went the next day by rail to a station on the border of the 'wet zone,' and thence five miles to a forest rest-house near a village were there are *thamin*. Only three days could be spared, and I saw no shootable stag. During long residence in the East one assimilates a certain amount of the oriental frame of mind, the resignation to 'kismet' being, in the present circumstances, of some benefit.

There is still space to say something of the many matters noticed. All the villages are surrounded with a formidable thorn fence, in which are gateways closed at night; this precaution being to protect the inhabitants from robbers and cattle thieves. In the 'wet zone' these fences are of the bamboo stockade type and quite impenetrable by stealthy people. There also were no jungle fires, and the forest was of a most pleasing greenness. Birds of beautiful plumage are numerous and one feels that there is life all about one, a great contrast to the deadly silence of the dry forests in which the leafless trees appeal in vain for moisture and the dry skeletons of numerous dead trees raise ghostly branches to the brassy sky.

There had been no animal voices in the night around the forest hamlet of the first camp; near the 'wet zone' village, after the dark pall of night had closed down on the jungle, the grunting of a panther was heard as he set out on his nightly prowl. And I heard the alarm call of a hind *thamin* as the scent of the brute came to her nostrils, trained by the hereditary instinct of many thousands of years, and the teachings of her mother, to know that here was the beast to be dreaded more than all else in the forest. The call has something of the four-horn and of that of the chital, but is different from either of these. It has a most pleasing and tuneful note.

It was towards the end of May that the quest of the bull *saing* was renewed, and a fine beast with 27-inch horns secured without incident. The accompanying photograph is of another animal, which may be taken to be his twin brother. A shootable *thamin* was not found, as the animals had scattered far and wide on the breaking of the rains. Everywhere the tracks of elephant and bison were seen, and a party of elephant catchers in the vicinity, licensed for kheddah operations, had been successful in capturing eleven animals.

The low-lying forests of Burma are exceedingly oppressive in temperature on the outbreak of the monsoon, so I was glad to close down shikar for a while and enjoy the peaceful repose of a journey down the Irrawaddy River on one of the comfortable steamers of the Flotilla Company, and so end my trip to Burma on a note of quiet enjoyment.

ON A SMALL COLLECTION OF FISH FROM THE BHAVANI RIVER (S. INDIA).

BY

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(*With three text-figures.*)

(Published with the permission of the Director, Zoological Survey of India.)

This note is based on a small collection made by Lt.-Col. R. W. Burton in the Bhavani River in the Coimbatore district, South India. The specimens were sent to Dr. S. L. Hora by the Curator of the Bombay Natural History Society. I am indebted to Dr. Hora for kindly placing the material in my hands for study. My best thanks are due to Lt.-Col. R. B. Seymour Sewell, Director of the Zoological Survey of India, for his kindness in going through the manuscript.

The collection comprises ten specimens only, which represent nine different species. In view of the fact that some of the species contained in the collection are hitherto known only from short and inadequate descriptions, opportunity is hereby taken to supply such additional or emended descriptions as are necessary for convenience of future reference from the present well-preserved specimens. The local Telugu names for the species are quoted from a list accompanying the collection.

Callichrous bimaculatus (Bloch).

1794. *Silurus bimaculatus*, Bloch, *Nat. Ausl. Fische*, VIII, p. 24.
1877. *Callichrous bimaculatus*, Day, *Fish. India*, p. 476, pl. cx. figs. 4 & 5.
1889. *Callichrous bimaculatus*, Day, *Faun. Brit. Ind.*, *Fish.* I, p. 131, fig. 57.
1927. *Callichrous bimaculatus*, Rao & Seshachar, *Half-yearly Journ. Mysore Univ.*, I, No. 2, p. 5.
1930. *Callichrous bimaculatus*, Prashad & Mukerji, *Journ. Bombay Nat. Hist. Soc.*, XXXIV, p. 165.

The entire body is dusky with the exception of the belly which is white. A round blackish blotch is present behind each opercle. The maxillary barbels are blackish, but the mandibulars are white.

One specimen	...	98 mm. long.
Local name	...	*Sottah barai.*

Aoria punctatus (Jerdon).

1849. *Bagrus punctatus*, Jerdon, *Madras Journ. Lit. & Sci.*, XV, p. 339.
1877. *Macrones punctatus*, Day, *Fish. India*, p. 445, pl. c, fig. 3.
1889. *Macrones punctatus*, Day, *Faun. Brit. Ind.*, *Fish.* I, p. 153.
1927. *Macrones punctatus*, Rao & Seshachar, *Half-yearly Journ. Mysore Univ.*, I, No. 2, p. 8.

The width of the head is equal to the length from the middle of the distance between the anterior border of the eyes and the nostrils to the posterior margin of the operculum. Its height is less than half its total length. The diameter of the eyes is contained 7 times in the length of the head, almost 2½ times in the length of the snout and the interorbital space. The pectoral spines are as long as the head behind the middle of the eyes. The external mandibular barbels extend beyond the base of the pectorals.

The fish has the characteristic colouration as described by Day.

One specimen	... 200 mm. long.
Local name	... *Kori tee.*

Barbus arulius (Jerdon).

1849. *Systomus arulius*, Jerdon, *Madras Journ. Lit. & Sci.*, XV, p. 317.
1877. *Barbus arulius*, Day, *Fish. India*, p. 575, pl. xiii, fig. 5.
1889. *Barbus arulius*, Day, *Faun. Brit. Ind.*, *Fish.* I, p. 322.
1909. *Barbus arulius*, Annandale, *Rec. Ind. Mus.*, III, p. 289.

Besides the two specimens of the species from the Bhavani River I have also examined the following specimens preserved in the collection of the Zoological Survey of India and the measurements and description given below are based on a study of all the specimens:—

2732 (Figured by Day) ...	Wynaad ...	Purchased from Day	...86mm
F5531/1	The Nilgiris ...	,, ,, ,,	...38mm.
F2555/1	Tenmalay, Travancore.	Annandale Coll.	...37mm.
F2556/1, F8069/1 ...	Kalatupuzhal ,,	,, ,,	...34mm.

The length of the head is contained from 3½ to 3⅔ times in the length of the body without the caudal fin. Its breadth is equal to its length behind the anterior third or the middle of the eyes. The height is almost equal to the length behind the anterior nostrils. The diameter of the eyes is contained 3¼ times in the length of the head. The snout is as long as the eyes while the interorbital region which is flat, is slightly less than one diameter in width.

A pair of very thin and short maxillary barbels[1] are present. They are shorter than the diameter of the eyes. In all the young specimens, however, the barbels are proportionately longer. The dorsal fin is inserted nearer to the tip of the snout than to the base of the caudal. Its outer margin is more or less straight. The last undivided dorsal ray is osseous but fairly weak. The pectorals are equal to the length of the head behind the anterior margin of the orbit and are separated from the base of the ventrals by a short distance ; but in young forms they very nearly reach the ventrals. The ventrals are situated just below the last undivided dorsal ray and are slightly longer than the pectorals. They extend only to the anal opening. In some fairly grown-up specimens as well as in the immature ones, however, they very nearly reach the anal ; which latter when laid flat does not meet the base of the caudal. The caudal is longer than the head and its own height.

There are 23–24 scales along the lateral line and 7 rows in a transverse series ; 4½ rows being between the dorsal fin and the lateral line and 2½ rows between the lateral line and the base of the ventral fins. There are 8 predorsal scales. The bases of the dorsal, anal and caudal fins are scaly. A prominent, fairly deep pectoral pit is characteristic of the species.

The general body colouration is olivaceous green. The portion above the lateral line is blackish. There are three black blotches on the sides of the body.

Two specimens	... 66 mm. long.
Local name	... *Pewal kendi*

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[1] Day's specimen from the Nilgiris has two pairs of barbels. The maxillaries are very long. They extend up to the posterior margin of the opercles and are about 2½ times the diameter of the eyes. The rostrals are much shorter and reach beyond the middle of the eyes. The specimen bears a close resemblance to *B. arulius* but owing to its bad state of preservation does not allow of any detailed examination.

Measurements in millimetres.

	No. 2732	Bhavani R.	$F\frac{8069}{1}$
Length of body without caudal ...	86·0	66·0	37·0
Height of body	31·0	26·0	12·5
Length of head	24·0	20·0	11·0
Breadth of head	14·5	11·0	7·0
Height of head	20·0	16·0	9·0
Length of snout	7·25	6·0	3·0
Diameter of eyes	7·5	6·0	4·0
Interorbital width	7·0	6·0	3·5
Height of dorsal fin	16·5	16·0	11·0
Height of last undivided dorsal ray...	12·5	12.0	8·0
Length of anal fin	15·0	14 0	6·0
Length of pectoral fins	18·0	14·5	8·25
Length of ventral fins	19·5	15·0	9·0
Length of caudal fin	...	22·5	12·5
Length of caudal peduncle ...	12·0	11·0	5·5
Least height of caudal peduncle ...	11·0	10·0	5·0

Barbus carnaticus (Jerdon).

1849. *Systomus Carnaticus.* Jerdon, *Madras Journ. Lit. & Sci.*, XV p. 315.
1878. *Barbus Carnaticus*, Day, *Fish. India*, p. 563, pl. cxxxvii, fig. 3.
1889. *Barbus Carnaticus*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 305.

The following specimens of the species are preserved in the collection of the Zoological Survey of India and have been examined :—

2312	...	Canara	...	Purchased from Day	...	62 mm.
2379	...	Bowanny	...	,, ,, ,,	...	240 mm.
2410	...	Bowanny	...	,, ,, ,,	...	35 mm.

D. 4/7 ; A. 3/5 ; P. 1/14 ; V. 1/8.

The length and the height of the head varies from $4\frac{1}{4}$ to $4\frac{3}{4}$ and 3 to $3\frac{2}{3}$ times respectively in the length of the body without the caudal, while its breadth is equal to its length behind the anterior margin, or anterior third or the middle of the eyes. The height of the body varies with age and is equal to the length of the head behind the anterior nostrils in fairly grown-up specimens while in young forms it is much less and equals the length of the head behind the anterior margin of the eyes. The diameter of the eyes is contained from 3 to $3\frac{1}{2}$ times in the length of the head. The snout is as long as the diameter of the eyes or slightly shorter. The interorbital space is flat and is from 1 to $1\frac{1}{2}$ times the orbital width. The lips are moderately fleshy. The upper jaw is slightly longer than the lower and considerably protrusible. The maxillary barbels are thin and as long as the diameter of the eyes, while the rostrals are considerably shorter. In grown-up specimens there are series of flat tubercles on the snout.

The insertion of the dorsal fin is considerably nearer to the tip of the snout than to the base of the caudal. The last undivided dorsal ray is strong and slightly curved inwards. In grown-up specimens it is as high as the body below it up to the insertion of the lateral line but in younger forms it is equal to or ⅘ the body height. The outer margin of the dorsal fin is slightly concave. The pectorals are as long as the head, but are much smaller in young individuals. They are separated from the base of the ventrals by a short distance. The origin of the ventrals is almost vertically below the insertion of the dorsal. They are slightly shorter than the pectorals and separated from the base of the anal. The insertion of the anal is almost equidistant from the base of the caudal and the origin of the ventrals. It is as long as the ventrals and, in some specimens, when laid flat, reaches the base of the caudal. The caudal fin is longer than the head and almost as high as long.

The scales are moderately large and there are 28–29 scales along the lateral line and 9 rows in a transverse series, 5½ rows being between the base of the dorsal fin and the lateral line and 3½ rows between the lateral line and the base of the ventrals. In specimen No. 2312 from Canara, however, there are only 8 rows of scales in a transverse series (4½ + 3½). The number of predorsal scales varies from 10 to 12. The dorsal, anal and caudal fins have scaly sheaths at the bases.

The colouration of the body is dark olivaceous green above the lateral line and lighter below. The outer margins of the scales are tipped with blackish pigments. There are 4 to 5 very fine and faint blackish longitudinal stripes along the body above the lateral line. The outer margin of the dorsal fin is blackish. All the fins are dusky. The rostral barbels are black.

One specimen...	120 mm. long.
Local name ...	*Shole kendi.*

This species is populary known as Carnatic carp. It is, however, ' doubtful how far this designation has any scientific basis, for, certain other species so called have no more than a distant resemblance to *Barbus carnaticus* (Jerdon).'[1]

Measurements in millimetres.

	No. 2379	Bhavani R.	No. 2312
Length of body without caudal fin ...	240·0	120·0	62·0
Height of body	78·0	35·0	17·0
Length of head	51·0	27·5	16·0
Breadth of head	36·0	18·0	8·5
Height of head	44·0	21·5	12·0
Length of snout...	16·5	7·5	4·5
Diameter of eyes	15·25	9·0	5·5
Interorbital width	23·0	11·0	4·5
Height of dorsal fin	49·0	26·5	15·5
Height of last undivided dorsal ray ...	42·0	26·5	15·5
Length of anal fin	53·0	20·0	10·0

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[1] Annandale, N.—*Rec. Ind. Mus.* XVI, p. 135 (1919).

	No. 2379	Bhavani R.	No. 2312
Length of pectoral fins	52·5	24·0	12·0
Length of ventral fins	51·0	21·0	11·0
Length of caudal fin	59·5	33·5	...
Length of caudal peduncle ...	31·5	16·5	8·0
Least height of caudal peduncle ...	30·0	14·0	7·0

Barbus micropogon, var. mysorensis Jerdon.

1849. *Barbus mysorensis*, Jerdon, *Madras Journ. Lit. & Sci.*, XV, p. 312.

Jerdon originally described the form from 'Cavery and its tributaries' in South India. His description is, however, very short and the only chief differentiating character that he mentioned is that the 'snout is prominent, raised, covered with mucous pores'. Day merged Jerdon's form in the synonymy of *B. micropogon* (Cuv. et Val.) and did not give it any status beyond saying that 'The variety *B. mysorensis*, Jerdon, has numerous large pores on the snout and preorbital.'[1] Besides the specimen from the Bhavani River, which I assign to Jerdon's form there is another similar but much bigger specimen (No. 2411) from 'Bowanny' (apparently Bhavani or Bhawani) in the collection of the Zoological Survey of India. This specimen bears a tag with the legend '*Barbus micropogon* (var.)' in Day's handwriting. I have very thoroughly examined the two specimens mentioned above and compared them with Day's *forma typica* of *B. micropogon* (No. 2398: figured by Day in his *Fishes of India*, pl. cxxxvi, fig. 3), from 'Wynaad' and have arrived at the definite conclusion that both the specimens from the Bhavani River, although closely allied to *B. micropogon*, are sufficiently distinct from it in the general outline of the body, the shape and size of the snout, etc. (Text-figs. 1 & 2) and should, therefore, be considered as a distinct form.

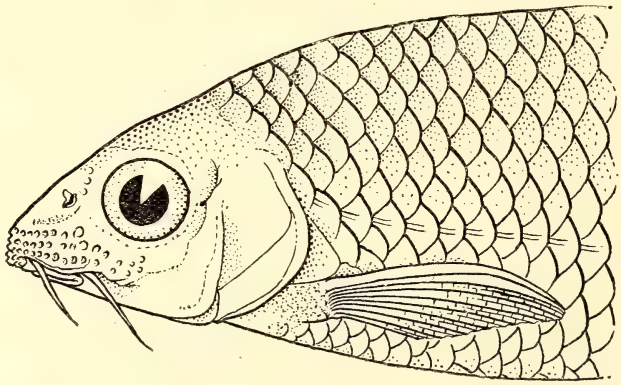

Fig. 1.—Lateral view of anterior portion of Day's specimen of *Barbus micropogon* var. *mysorensis*. (Nat. size).

D. 4/9; A. 3/5; P. 1/14; V. 1/9.

The head is short and cone-shaped. Its length is contained 4¼ times in the length of the body without the caudal. The breadth is equal to its length behind the anterior third of the eyes. The height equals its length excluding the snout. The eyes are situated in the middle of the head; they are fairly large and are contained $3\frac{1}{2}$ times in the length of the head. The interorbital region is more or less flat and is wider than the diameter of the eyes. The snout is obtusely pointed, longer than the orbital width and covered with series of horny cone-shaped and pointed tubercles which extend as far back as the anterior margin of the eyes. There are some similar tubercles on the preorbital region also. The mouth is horse-shoe shaped and its gape is moderate. The lips are fleshy. The maxillary barbels are longer than the diameter of the eyes while the rostrals are about $\frac{3}{4}$ the length of the maxillaries.

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[1] Day, F. *Fishes of India*, p. 563 (1878).

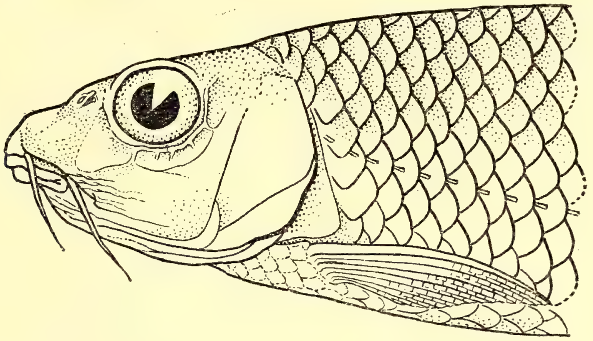

Fig. 2.—Lateral view of anterior portion of Day's specimen of *Barbus micropogon.* (Nat. size).

The dorsal fin is situated nearer to the tip of the snout than to the base of the caudal. Its outer margin is concave. The last undivided dorsal ray is smooth, very strong, flat and is almost as long as or slightly longer than the depth of the body below it. The base of the dorsal is equal to the length of the head behind the anterior margin or anterior third of the orbit. The pectorals are considerably shorter than the head and are separated from the origin of the ventrals by a short distance. The ventrals are inserted vertically below or slightly posterior to the insertion of the dorsal and are almost equal to or a little shorter than the pectorals. They are separated from the origin of the anal by a distance equalling half its own length. The anal is inserted midway between the origin of the ventrals and the base of the caudal. It is rather short with a more or less rounded outer margin, and, when laid flat, extends only to the middle of the caudal peduncle. The caudal fin is deeply furcate with equal pointed lobes. It is nearly $1\frac{1}{2}$ times longer than high. The scales are regularly arranged. There are 41–42 scales along the lateral line, 11 rows ($7\frac{1}{2} + 3\frac{1}{2}$) in a transverse series and 15 before the dorsal fin.

The general colouration of the body is olivaceous green with the dorsum comparatively dark. The outer margin of the dorsal and the anal fins are faintly tipped with black.

One specimen	...	135 mm. long.
Local name	...	*Korhi arranz.*

The following table shows some of the chief characters that differentiate Jerdon's form from *B. micropogon* (*sensu stricto*):—

B. micropogon var. mysorensis.	**B. micropogon.**
1. Head $4\frac{1}{4}$ times in length of body.	1. Head less than 4 times in length of body.
2. Snout pointed and covered with pointed tubercles.	2. Snout blunt and without tubercles.
3. Anal fin when laid flat extends to the middle of caudal peduncle.	3. Anal fin when laid flat extends to the base of caudal fin.
4. 41–42 scales along lateral line.	4. 38–39 scales along lateral line.
5. 14–15 predorsal scales.	5. 12 predorsal scales.

Rao and Seshachar (*op. cit.*, p. 16) reported a form under the denomination *B. micropogon* from Mysore and observed that 'Mysore is known for its very large specimens of this fish. Especially the Cauvery supplies us a very large number of these fish.' Since 'Cavery' is the type-locality of Jerdon's form, it seems probable that the authors had the variety *mysorensis* before them.

Measurements in millimetres.

	B. micropogon var. *mysorensis.*		*B. micropogon.*
	No. 2411.	Bhavani R.	No. 2398.
Length of body without caudal fin ...	170·	135·0	152·0
Height of the body	48·0	39·0	43·0
Length of head	38·0	34·0	40·0
Breadth of head	22·0	22·0	23·0
Height of head	28·5	25·0	28·0
Length of snout	15·0	12·0	14·0
Diameter of eyes	12·0	11·0	11·5
Interorbital width	13·5	11·0	11·5
Height of dorsal fin	43·0	42·0	42·0
Height of last undivided dorsal ray ...	42·5	41·5	42·5
Length of anal fin	29·0	22·5	28·5
Length of pectoral fins	32·5	29·0	30·0
Length of ventral fins	31·	27·0	27·0
Length of caudal fin	35·0	...	40·0
Length of caudal peduncle ...	28·5	23·5	21·0
Least height of caudal peduncle ...	18·0	15·0	16·0

Danio (Danio) æquipinnatus (McClell.).

1839. *Perilampus æquipinnatus*, McClelland, *Asiat. Research*, XIX (2), p. 383, pl. lx, fig. 1.
1878. *Danio æquipinnatus*, Day, *Fish. India*, p. 596, pl. cl. fig. 5.
1889. *Danio æquipinnatus*, Day, *Faun. Brit. Ind.*, *Fish*, I, p. 356, fig. 111.
1929. *Danio æquipinnatus*, Prashad & Mukerji, *Rec. Ind. Mus.*, XXXI, p. 20.

Myers[1] observes that in this species the insertion of the anal is 'under about the ninth dorsal ray'. I have examined a large series of specimens of this species from various localities in India, Burma, Siam, etc., and find that the anal is situated vertically below the sixth or the seventh dorsal ray. Further, according to him the rostral barbels are 'as long as eye'. But in all the specimens that I have examined they are generally half to three-fourths the orbital width.

One specimen	...	61 mm. long.
Local name	...	*Orichik condee.*

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[1] Myers, G. S.—*Amer. Mus. Novitates*, No. 150, p. 3 (1924).

Barilius gatensis (Cuv. et Val.).

1844. *Leuciscus gatensis,* Cuvier & Valenciennes, *Hist. Nat. Poisson,* XVII, p. 309, pl. 503.
1878. *Barilius gatensis,* Day, *Fish. India,* p. 592, pl. cxlix, fig. 2.
1889. *Barilius gatensis,* Day, *Faun. Brit. Ind., Fish.,* I, p. 349.
1924. *Barilius gatensis,* Fowler, *Acad. Nat. Sci. Phild.,* lxxvi, p. 78.

I have examined Day's two specimens of the species (Cat. 871) from the Nilgiris and I find that in both of these as well as in the individual from the Bhavani River, there are present very thin and short maxillary barbels. The specimens are provided with a series of small pointed tubercles on the snout, some portion of the cheek and the lower jaw. The pectoral fins are as long as the head behind the anterior third of the eyes and almost reach the ventrals, which latter extend only to the vent. The length of the anal fin is as long as the length of the head behind the middle of the eyes.

There are 12 vertical black bars descending from 3 scales below the dorsal line. Six or seven smaller and much narrower bars originate from a couple of scales below and alternate with the first series. They extend further down than those in the first row.

One specimen	...	73 mm. long.
Local name	...	*Wa-nati kendi.*

Scaphiodon brevidorsalis (Day).

1873. *Semiplotus brevidorsalis,* Day, *Proc. Zool. Soc. London,* p. 239.
1877. *Scaphiodon brevidorsalis,* Day, *Fish. India,* p. 552, pl. cxxxiii, fig. 2.
1889. *Scaphiodon brevidorsalis,* Day, *Faun. Brit Ind., Fish.,* I, p. 286, fig. 98.[1]
1927. *Scaphiodon brevidorsalis,* Rao & Seshachar, *Half-yearly Journ. Mysore Univ.,* I, No. 2, p. 15.

D. 3/11 ; A. 3/5 ; P. 1/13 ; V. 1/9.

The length of the head, of the caudal fin and the height of the body are contained 4¼, slightly less than 4 and a little over 3 times respectively in the length of the body without the caudal. The eyes are situated almost in the middle of the length of the head and are contained 3 times in the length of the latter. There are several rows of small tubercles across the snout.

The origin of the dorsal fin is nearer to the tip of the snout than to the base of the caudal. The last osseous ray is shorter than the longest branched ray and is nearly equal to the length of the head. The pectorals are slightly shorter than the length of the head and do not extend to the base of the ventrals which latter are as long as the former and do not quite reach the base of the anal.

The body above the lateral line is dusky while the portion below is yellowish to white. There is a blackish band along the lateral line from behind the angle of the opercles to the base of the caudal fin.

One specimen	...	76 mm. long.
Local name	...	*Patty kendi.*

Scaphiodon nashii (Day).

1868. *Barbus Nashii,* Day, *Proc. Zool. Soc. London,* p. 584.
1877. *Scaphiodon Nashii,* Day, *Fish. India,* p. 552, pl. cxxxiii, fig. 3.
1889. *Scaphiodon nashii,* Day, *Faun. Brit. Ind., Fish.,* I, p. 285.
1927. *Scaphiodon nashii,* Rao & Seshachar, *Half-yearly Journ. Mysore Univ.,* I, No. 2, p. 15.

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[1] The figure 98 in the *Fauna of British India, Fishes,* I, p. 286, has wrongly been referred to *Scaphiodon brevidorsalis* by Day. It is, in fact, a reduced replica of the figure of *Scaphiodon nashii* published in his *Fishes of India,* pl. cxxxiii, fig. 3.

D. 3/11 ; A. 3/5 ; P. 1/13 ; V. 1/9.

The length of the head, of the caudal fin and the height of the body are contained $4\frac{1}{2}$, $3\frac{1}{2}$ and $3\frac{1}{3}$ times respectively in the length of the body without the caudal fin. The head is slightly higher than broad. The eyes are situated almost in the middle of the length of the head. The interorbital space is more or less flat and equal to $1\frac{1}{4}$ the diameter of the eyes. The snout is slightly longer than the orbital width, and covered with series of tubercles.

The mouth is very characteristic (Text fig. 3). It is small and horse-shoe shaped with rather thick and continuous lips. The horny covering of the lower jaw is somewhat swollen but not very hard. Day[1] observes that the 'mouth in this species alters so with age, that until I had compared specimens of my *Osteochilus malabaricus*[2] with gradations of *Scaphiodon Nashii* since obtained I could not have believed in their being identical. In the young the jaws are compressed, each with a cartilaginous covering ; the lips are thick and continuous, not continued across the chin. As age increases the mouth widens, the cartilaginous covering becomes more horny, and the colour of the fish alters.' This description agrees very closely with the character of the mouth of the specimen from the Bhavani River.

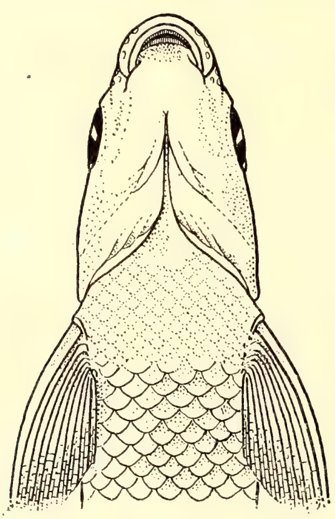

Fig. 3.—Ventral view of *Scaphiodon nashii* from Bhavani River. x $1\frac{1}{2}$.

The origin of the dorsal fin is much nearer to the tip of the snout than to the base of the caudal. The longest ray of the dorsal fin is nearly $1\frac{1}{3}$ times in the depth of the body below it. The last undivided dorsal ray is rather weak. The base of the dorsal fin is almost equal to its height. The outer margin is more or less straight. The pectorals are falciform, slightly smaller than the head and separated from the origin of the ventrals by a considerable distance. The ventrals are inserted vertically below the 4th branched ray of the dorsal, shorter than the pectorals and extend to the anal opening. The anal is twice as long as it is broad at the base and does not quite reach the caudal. The caudal is deeply furcate and is longer than it is high at its free end. The central rays which are the shortest are about $4\frac{1}{2}$ times in the entire length of the fin.

There are 40-41 scales along the lateral line, $12\frac{1}{2}$ rows in a transverse series, $7\frac{1}{2}$ rows being above the lateral line and 5 rows between the lateral line and the base of the ventrals. In front of the origin of the dorsal there are 18 scales. The colouration of the specimen agrees entirely with Day's description.

One specimen	...	115 mm. long.
Local name	...	*Kari moti kandi.*

Remarks.—In general facies, character of the pharyngeal bone and teeth, etc., the specimen agrees perfectly with a *Scaphiodon*. The proportions of its body, the position and composition of the fins and the characteristic colouration highly suggest that it is *S. nashii*. It is only the shape of the mouth and the character of the lips that are unlike a *Scaphiodon*. Unfortunately, I have no authenticated material of this species at my disposal at present for comparison, and I have, therefore, greatly relied on Day's remarks in regard to the variability of the shape and size of the mouth and the lips in this species.

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[1] Day, F.—*Fishes of India*, p. 552, foot-note.

[2] In all probability this is a misnomer. Day does not seem to have called anything by this name.

Measurements in millimetres.

	Bhavani R.
Length of body without caudal fin	115·0
Height of body	35·0
Length of head	25·0
Breadth of head	16·0
Height of head	19·0
Length of snout	9·0
Diameter of eyes	8·0
Interorbital width	10·0
Height of dorsal fin	23·5
Height of last undivided dorsal ray	23·5
Length of anal fin	23·0
Length of pectoral fins	24·0
Length of ventral fins	23·5
Length of caudal fin	34·5
Length of caudal peduncle	17·0
Least height of caudal peduncle	14·0

THE BUTTERFLIES OF THE SIMLA HILLS

BY

G. W. V. deRhe-Philipe, F.E.S.

Part I

The passion for collecting something is ingrained in most of us, and Nature around very frequently provides the material for the satisfaction of this trait in our characters. Yet, in spite of its wonderful wealth of insect life, the collection and study of butterflies and moths is not exactly a 'popular' hobby in India. For one thing, there is, as a rule, too little leisure; and the climate, except perhaps in the Hills, is apt to discourage and damp the enthusiasm of the few who have the time and inclination for the field work which is not only an important but also the most fascinating side of the pursuit of any branch of Natural History. But more responsible than anything else for this lack of interest is perhaps the fact that the path of the aspiring entomologist or botanist to the deeper knowledge by which alone interest can be maintained is so beset with difficulties. He has not, as in England and America, comparatively cheap and easily obtainable hand-books on his subject to aid and encourage him through his early perplexities of classification and nomenclature; nor has he, to any appreciable extent, the stimulation provided by the example of others with the same bent, or the advantages of companionship and co-operation in mutual interests enjoyed in the membership of Natural History Associations and Clubs.

There is little doubt, however, that the study of the Indian Lepidoptera is beginning to appeal to a much wider circle than has hitherto been the case. Till now, the field of butterflies has been limited to a comparatively small group of workers such as Atkinson, Marshall, Watson, Bingham, Bell, deNiceville and Evans, whose attentions have been directed more to the butterflies of India as a whole, and whose books are the standard works on the subject. India is, however, almost a continent with large areas which are quite distinctive climatically and zoologically; and unless the fauna of each of these is studied and listed, the records of distribution of species and races must, to some extent, be incomplete. Brigadier Evans' latest work, the 'Identification of Indian Butterflies', which recently appeared in the *Journal of the Bombay Natural History Society* and has since been published in book form, has brought these records up to the limits of our present knowledge; and the fact that he has not only been able to extend the previously known distribution of some species, but has also been able to add some new species and to separate clearly differentiated local races of many old species, is in itself proof that there is still work to be done.

There is another direction in which our knowledge of Indian butterflies is still very backward. This is in connection with the egg, larval and pupal stages of the life history of a large number of species. Mr. T. R. Bell has broken new ground here, and his papers on the 'Common Butterflies of the Plains of India', which also appeared in the Journal, have done much towards adding to our former scanty store of information. But his work has lain more in the districts of Western and Southern India, and there is still a large field for similar observation and study in the northern and eastern areas and in Burma. In India, unfortunately, this branch of work presents some difficulties. It needs some degree of settled residence, not interrupted by long absences from headquarters and not subjected to sudden transfers; and it demands time and infinite patience. There are not too many folk in India who work under these happy conditions; but there is so much to be done that it is to be hoped that naturalists in these localities, with inclination and facilities for this side of the subject, will turn their attention to it and record the results.

Still, there is much useful work which can be done even by those who cannot find opportunities for breeding and studying the earlier stages of their butterflies. Gaps in our knowledge of butterfly life in India have yet to be filled ; and this can be done by the observation, study and listing of the species and races to be found in each of the districts of the country, with notes of the times and periods of their appearance, nature of the localities usually affected by each, and descriptions of seasonal and other variations, if any. Such lists not only provide specialist students with valuable information as to the distribution of species and local races and phases of their life-history, but will also, if available and obtainable, encourage and help many others who, I am sure, are collectors and students in embryo, but who are deterred from anything beyond mere ' collecting ' by the absence of literature on their hobby.

Some particular localities in India have already been worked over by a few enthusiasts. The results have been recorded and may be found in the Journals of the Bombay Natural History Society, of the Asiatic Society of Bengal, and occasionally in the Transactions and Proceedings of the Zoological and Entomological Societies of London. It is unfortunate that these are not easily traceable and not always readily obtainable ; but they do exist, and any one who is keen could probably get copies of what he wants by enlisting the aid of the Societies. A list of these ' Lists ' or papers would be useful and I hope at some future date to get one out.

Some of these lists were made up very many years ago and could probably be revised and brought up to date with advantage ; while there is little doubt that all could be added to from time to time. And the lists we have, do not, by any manner of means, complete the Indian region. The Madras plains and the Mysore plateau have certainly not been fully explored, nor have the Eastern coastal districts and Ghats where a very interesting butterfly fauna should be found. The upland plains of Central India and Chota Nagpur, with their broken-up hills and large areas of forest country, must be the home of many fine insects, but, though we know of many to be found there, we have no really complete list of the butterfly inhabitants. Assam is a butterfly collectors' paradise, and though we have records of what may be found in the Khasi Hills, the Naga Hills and in Cachar, these cover only a small portion of its hill country and there is yet much to learn of the insects of its river valleys and its vast forests. Parts of the long Gangetic Plain and of the Punjab and much of the arid deserts of Rajputana and Sind still remain to be worked up. Very little is known of the butterflies of Baluchistan and the North-West Frontier regions, where we get a quite distinct type of fauna. And there are still many gaps in the listing of the long stretch of the Himalayan Range with its gradual variations of fauna from the Palearctic type of the extreme northwest to the Indo-Malayan groups of the East.

One of these gaps is the area from and including Kashmir in the north to Mussoorie and its environs in the south-east. Brigadier Evans has given us a list of the butterflies in the Chitral country, and Mr. Mackinnon, years ago, made a very complete catalogue of what were found in and around Mussoorie. It might be thought that these two lists would be a sufficient guide to the fauna of the intervening tracts of the same mountainous country, but it is rather an interesting fact that this is not the case. The Chitral butterflies are distinctly and preponderatingly Palearctic ; and as we proceed south-eastwards there is a gradual but quite definite change till, by the time we reach Mussoorie and Kumaon, there is a strong element of the eastern fauna. Several species are, it is true, to be found throughout this stretch of country ; but there are others which while common in, say Kashmir, are distinctly rare by the time we get to Dalhousie and will not be found at all in the Simla District. Conversely, there are quite a number of species which figure in the Mussoorie lists and are not rare there, which are scarcer and scarcer as we proceed west and finally disappear altogether from the local fauna.

With its large European population and its schools, there are probably more collectors of sorts in Simla than in any other locality in India, the Darjeeling Hills perhaps excepted. In my butterfly expeditions round Simla, I met many more folk—grown-up people, not only schoolboys—with nets and collecting impedimenta than I had done anywhere else in all my wanderings in India. It was quite a common experience, when exploring some likely nullah, to come across one or two others bent on the same mission ; and there were far more opportunities for talking 'butterflies' than is usually the case in an Indian station.

Yet, strange though it may seem, there appears to be no list or account of the butterflies which are to be found in the hill districts of which Simla is the headquarters. At any rate, I have not been able to discover any such compilation, and I know of others anxious to obtain information who were equally unsuccessful. I propose, in this paper, to try and supply this want; and I hope it will be of use, not only to the many school lads in Simla who are keen on this matter and to others who take it up as a recreation during a period of service there, but also to more advanced workers in their researches into the distribution of species and races.

My notes are based mainly on my own collecting and observations during occasional visits to Simla between 1911 and 1921 and during a four year period of service there later. I have, in addition, embodied all information and particulars I have gathered at various times from other collectors working in the area, and I have to thank many, and notably Brigadier Evans, for a good deal of interesting and useful information. The list should be fairly complete. especially as I have included, marked with an asterisk, all species of which I have no personal experience or first-hand knowledge but which have been recorded from the neighbourhood by various writers. A few other species, though they do not yet appear to have been taken within the limits, may reasonably be expected to occur and will possibly be discovered as time goes on. These will be mentioned and I will leave it to future workers to record their actual occurrence, if ever this is definitely established.

Before dealing with the various species themselves, it will, perhaps, be as well to give a brief description of the country to which these notes more particularly apply; and to mention some of the localities which my own experience has shown to be good *general* collecting grounds. The area covered is roughly that within a fifty mile radius of Simla and takes in the tract of mountain and valley from the spurs of the Sewaliks below Kalka to the upper reaches of the Sutlej and Giri rivers. It lies wholly within the outer ranges of the Himalayas; and situated thus, provides a great variation of altitude from the 2,000 ft. above sea level of Kalka and the valleys debouching into the plains to the 12,000 and 13,000 ft. of mountain masses like Huttoo and M'Arali and other peaks of the interior. Every description of country, except, of course, expanses of flat plains, is to be found—the broken foothills and nullahs bordering on the Dun, deep valleys like those of the Gumber and Asni and similar streams, the low basins of the Sutlej and Giri rivers, bare expanses of grass lands on the southern slopes of the numerous spurs, heavy and damp forests such as those on the inner faces of Jakko, Shali and Huttoo, and open and wind swept hill-tops ten thousand feet and more up in the air. We might, indeed, by extending the area a little further inland, get into the regions of snow in the mighty mountains and high passes just beyond the Sutlej and bordering on Kulu.

With such a range of altitude and such a variety of terrain, there is naturally a corresponding diversity of vegetation. It changes from the sub-tropical jungle of the lower foothills, past the cacti and long-leafed pines and rank grasses of the outer spurs, to the deodars and silver oaks and ilex of Simla and its environs, and on to the brown oaks and firs of the Huttoo forests and the semi-alpine flora of the inner mountains. Collet's 'Flora Simlaensis', though written many years ago and rather severely botanical, is a mine of information on the vegetation of the District; but to the ordinary individual, interested in the trees he sees as he proceeds into the Hills or wanders about the country, I would commend a little pamphlet in which was reproduced a lecture on the subject once given by E. C. Buck to a long defunct Simla Natural History Society. I cannot say whether it is still possible to get this publication; but if so, it will be found to give a very vivid and fascinating account of the trees of the different zones.

Butterflies are to be seen in Simla practically all the year round. They are naturally not prominent in the cold winter months, but I have seen Vanessas and a stray Colias or two even in December and January with snow on the ground. Down near Kalka quite a variety are to be seen right through the cold months. They are most abundant and varied in the late spring and early summer; and, after a period of comparative thinning out during the fogs and wet of the monsoon, they come into their own again in the gorgeous weather of the autumn weeks. There is thus always some interest for the collector; but the best months are undoubtedly May and June and from mid-September to the end of October. To get even a moderately representative series, one must be on the *qui vive* all through the weeks from the days when the first signs of spring appear till the frosts come in November and December. Quite a number of the species which are on the wing in the spring and summer do not appear at all after the monsoon has broken; and, conversely, some of the autumn species have no spring broods. Not a few kinds, moreover, have a very short period of flight—possibly not more than a fortnight or three weeks—and if not taken then, will not be seen again till the following year.

All the more common species can be seen and taken almost anywhere, and it is quite worth while spending half an hour in a sunny garden or on some open saddle on the ridges. But the earnest seeker after good things must go further afield and work for them in their own particular haunts. As a general rule, nullahs where there is a stream of running water and which are not too heavily wooded are good collecting grounds. So also are open plateaus on hill tops and some dips in the ridges and clearings through the woods which many butterflies seem to use as passages for flight from one locality to another. The grassy slopes of some of the spurs are often surprisingly rich in the sun-loving varieties. There are many such favoured spots in Simla or within easy reach and any one who does a bit of wandering with a net will soon discover several for himself. Apart from 'popular resorts', the rambler at large, moving away from highways and byways, will often come upon some patch of ground favoured by some special species, and thus, in the course of an hour or so, pick up quite a nice little group of some kind he may have been waiting for years to find.

One of the very best collecting grounds I know is the San Damiano nullah behind the Mashobra-Mahasu ridge. It is worth a periodical visit, even from Simla. There is quite a good one behind Jakko, while the little valley beyond Summer Hill, running down to the Chadwick Falls, usually teems with insect life. Some years ago, the bed of the Simla River and the stream flowing past Annandale were worth exploring, but I have not been to these in recent years. The Glen is fair, but is usually too thickly overgrown for comfort. Annandale was once a favourite collecting ground for boys, but has now, I think, become too much of a laid-out pleasure-ground to attract any but the more common species; while the Waterworks area, once an excellent butterfly locality, is now closed to the public. Other places round Simla worth an occasional visit are the grassy slopes of the spur below Bishop Cotton's School, the glades and nullahs on the Tara Devi Hill, certain stretches of the Himalayan-Tibet road between the old toll bar and Mashobra and between Mahasu and Fagu; while the country round Mahasu itself and, very especially, the plateau on the top of Kufri Hill should, under no circumstances, be neglected. Of spots further afield, I might mention some of the valleys and ravines which abound in the broken country round Kalka, the bridle path up to Kasauli, the nullahs and open hill sides between Solon Brewery and Kandaghat on the railway, the ridge along which runs the road from Simla to Chail, the road from Narkanda to Baghi and beyond, and the slopes and plateaus on Huttoo. I believe, though I have not been able to explore it myself, that good butterflies are to be found along the road to Mussoorie where it rises to Paternalla to cross the ridge leading to the Chor, and the Chor itself should give good hunting.

An energetic collector, with patience and powers of observation, who can give a little time each season to these localities and can, in addition, look over some of the higher country beyond the Sutlej and bordering on Tibet, should be able, in the course of three or four years, to get together a very representative series of the butterflies of this part of the North-west Himalayas. As will be seen from the list which follows, a complete collection would include something like two hundred and fifty species or distinct local races—a total large enough to sustain interest for a very long time. Some of these butterflies are extraordinarily rare—within the district at any rate—but there is always the hope of picking up these prizes. There is the chance, too, that species not hitherto recorded from this part of the country will be discovered either as wanderers from their own proper habitat or as having established themselves in some out of the way spot not yet explored by collectors. Would it be too much to ask of any one who has such fortune, that he should report the find in some Society's Journal? It is only in this way that complete lists can be maintained.

In the earlier stages of butterfly nomenclature in India, many insects were either, on the one hand, given individual specific rank though almost indistinguishably near to already known and named species; or were, on the other hand, merged with other species though presenting constant minor variations. Modern science is developing the practice of differentiating groups which show constant variation as clearly defined local races of an earlier named specific type and the adoption of the trinomial system of nomenclature to denote the place within the species. Brigadier Evans, in his recent valuable work on the 'Identification of Indian Butterflies', has used this system as far as it is possible in the present state of our knowledge, and I follow him throughout.

There has been, in recent years, a change in the order in which the various families are placed. Earlier writers put the *Danaidæ* and *Nymphalidæ* first, followed by the *Lycænidæ* and then by the *Papilionidæ*, *Pieridæ* and *Hesperidæ*. Seitz, in his *Macrolepidoptera of the World*, has brought the *Papilionidæ* and *Pieridæ* to the front of the order, and modern authorities generally adopt this arrangement. I have compiled my list accordingly.

Each species or recognized race which has been definitely recorded from the area dealt with, is given a serial number in the list. Any not actually reported but which there is a reasonable chance of finding, are mentinoned without a serial number. The reference numbers in brackets (e.g. Bing. 33, de N. 272, Ev. F5(8)), are those under which the species appear in *The Fauna of India*, 'Butterflies', *The Butterflies of India*, and the *Identification of Indian Butterflies*. These will indicate to the reader where a full diagnosis and description of the insect may be found.

PAPILIONIDÆ.

As might be expected in a region where the Palearctic type predominates, the Papilios are not very prominent in the Simla Hills. Several species are to be found, but only a very few are in any sense common, and then only in the country bordering on the plains or in their more favoured haunts. Most of the species found are distinctly rare. Few as they are, however, the Papilios provide some of the largest as well as the most striking butterflies of the district.

Byasa aristolochiæ aristolochiæ. Fabricus

(Bing. 490; Ev. A 2 (10)).

This insect is very common in Southern and Continental India and appears occasionally in the Eastern and Central Punjab, but I have never come across it in the hills round Simla nor have I been able to trace a definite record of its capture. It is, however, not at all improbable that an odd specimen or two would be picked up in the country below Kalka.

1. **Byasa philoxenus philoxenus.** Gray.

(Bing. 500; Ev. A2 (15)).

2. **Byasa dasarada ravana.** Moore.

(Bing. 500; Ev. A2 (16)).

These two closely-related species are very similar in appearance and flight and, indeed, have not always been separated. They might well be dealt with together. Neither is often taken or seen in collections made in the district. I have seen butterflies which certainly were one or the other of these species on two or three occasions—always in the spring or early summer months—flying down the hill on the Simla-Mashobra road below the Retreat. They seem to have a most annoying habit of flying high out of reach.

3. **Chilasa agestor govindra.** Moore.

(Bing. 529; Ev. A3 (1)).

Is said not to be rare, but for all that, is seldom seen in collections. This is probably because it is on the wing for a short period only and then in the very early spring weeks before people have moved up from the plains and before those who winter in Simla think it worth while bringing out their nets. A friend who was keen enough to go out at this unpromising season, told me had taken two or three each spring flying round the oak trees high up on Jakko ; and I once saw one myself in similar surroundings on Summer Hill.

4. **Chilasa clytia clytia.** Linnæus.

(Bing. 532 ; Ev. A 3 (5)).

The *dissimilis* form of this species is found along the foot of the Himalayas, commonly as far west as the Mussoorie Dun, and very much more rarely further west. I have seen one or two specimens said to have been caught in the wooded country where the Ghaggar river emerges from the hills.

* 5. **Papilio protenor protenor.** Cramer.

(Bing. 515 ; Ev. A 4 (6)).

Has been recorded as occurring between Kashmir and Kumaon, but I have no personal knowledge of its having been taken anywhere west of Mussoorie. It is not common even there and would be still rarer to the west.

6. **Papilio polyctor polyctor.** Boisduval.

(Bing. 538 ; Ev. A 4 (9)).

This beautiful butterfly, the 'moonal' of the Simla school boy, is not uncommon in the localities it especially favours, and may sometimes even be seen in gardens in Simla. There generally seem to be a few flying about the grassy slopes of the hillsides near Salogra station on the Kalka-Simla Railway, and it was at one time fairly abundant along the toe of the Kaithu spur and in the valley between this spur and Elysium Hill. It is also fond of open nullahs where there is running water. Flies throughout the spring, summer and early autumn. Usually difficult to obtain in perfect condition as the tails break off very easily, and particularly so in the autumn when most of the specimens are badly worn.

* 7. **Papilio arcturus arius.** Rothschild.

(Bing. 541 ; Ev. A 4 (11)).

Another bbauty of the insect world. Common in the spring and summer in Kashmir and the adjoining hills from 8,000 to 10,000 ft., but becoming rarer eastwards. In the Simla Hills, it will be found only in the inner hills in the Huttoo-Baghi country, though it may also occur on the Chor range.

8. **Papilio polytes romulus.** Cramer.

(Bing. 522 ; Ev. A 4 (25)).

Not uncommon in the plains and lower hills where I have seen it within a few miles of Kalka ; but it does not, as far as my experience goes, extend to any distance into the hills. The monsoon and early autumn months seem to be the best times for it.

9. **Papilio demoleus demoleus.** Linnæus.

(Bing. 507 ; Ev. A 4 (27)).

Very common in the plains and lower hills but does not extend beyond the zone of the lime tree on which its larva feeds. I have seen specimens in the neighbourhood of Kalka, and it may perhaps go up as high as Solon ; but anything beyond this, would be most unusual. Flies spring and autumn.

10. **Papilio machaon sphyrus.** Hubner.

(Bing. 505 ; Ev. A 4 (29)).

This eastern cousin of our English 'swallow tail' is common in the spring and autumn. May be seen almost anywhere above 5,000 ft., but grassy slopes and meadows are its favourite country. It was often almost abundant on the summit of Kufri Hill and around Narkanda. Once, as a boy very many years ago, I found this butterfly in large numbers on the lower slopes of the Kaithu spur, where its larvæ swarmed on an evil smelling shrub which is common at lower elevations in these hills.

* 11. **Pathysa eurous kashmirensis.** Rothschild.

(Bing. 548 ; Ev. A 5 (1)).

Recorded from ' Kashmir to Kumaon ', but I have never come across it in the Simla Hills. On the analogy of its habits in the more easterly part of its range, it should be found only at low elevations near the foot of the hills.

12. **Zetides sarpedon sarpedon.** Linnæus.

(Bing. 557 ; Ev. A 6 (2)).

Not particulary common anywhere in the area, but may be seen occasionally from about 7,000 ft. downwards in the summer and early autumn. Is attracted by flowers round which I have taken nearly all my specimens here and elsewhere.

13. **Zetides cloanthus.** Westwood.

(Bing. 556 ; Ev. A 6 (1)).

Not uncommon, but needs looking for. This butterfly has a most exasperating habit of flying round some favourite tree—often an isolated one—out of reach of the net. It is consequently not generally easy to capture. I remember one particular tree on the top of Kufri Hill where it was almost a certain find. I have also taken it on Jakko and on the Kaithu spur in exactly similar circumstances. Sometimes frequents the beds of hill streams where it settles on patches of damp sand. Flies June to October and even November. It does not, in the Western Himalayas, go much below 5,000 ft.

* 14. **Parnassius jacquemontii jacquemontii.** Boisduval.

(Bing. 561 ; Ev. A 13 (2)).

* 15. **Parnassius epaphus epaphus.** Oberthur.

(Bing. 562 ; Ev. A 13 (3))

Both of these ' Apollos ' are essentially Alpine insects. They are to be found from Kashmir to Kumaon, but not below 11,000 to 12,000 ft., and would therefore be confined to the higher ranges of the interior. I have not taken either myself within the district, but it is possible that they may sometimes fly on Huttoo and other peaks.

16. **Parnassius hardwickeii hardwickeii.** Gray.

(Bing. 543 ; Ev. A 13 (4)).

The only species of the genus which, in the Himalayas, comes down to comparatively low elevations. It may be taken even in Simla, where I have seen it more than once within the station, the slopes near Sanjouli generally harbouring one or two. To find it at all commonly we must, however, go further inland. The plateau on Kufri Hill, Narkanda and Huttoo will almost invariably produce specimens. Is on the wing both in the spring and early summer and in the autumn ; and, since it is a butterfly of the snows, it will probably be found in the winter months. I have taken it late in November at any rate. It affects open slopes and meadows where there is grass and alpine vegetation.

PIERIDÆ.

Several of the species are so abundant in individuals, that the Pieridæ, in contrast to the Papilios, are always a good deal in evidence among the butterflies of the Simla Hills. They do not, as a general rule, like heavily wooded country, but in more open surroundings, they will be found abroad everywhere in gardens, in the meadows and about the grass slopes ; along the nullahs and in and out of the scrub. Some of the different species of each genus are so alike that it is usually advisable to catch and examine even the most ordinary looking individuals at any rate till some sort of familarity with their respective little ways has been attained.

Baltia butleri butleri. Moore.

(Bing. 583 ; Ev. B 2 (2)).

Included on the strength of having been recorded 'from Kashmir to Kumaon', but I doubt whether it will be found anywhere nearer than the Tibet border.

Synchlœ ausonia daphalis. Moore.

(Bing. 602 ; Ev. B3 (3)).

Also recorded from the North-West Himalayas, but I have not met it anywhere nearer than the extreme north of the Punjab. It may perhaps be found straggling into the edge of our limits in the interior.

Pieris calidice kalora. Moore.

(Bing. 600 ; Ev. B 4 (2)).

Another higher Alpine species which, from its recorded distribution, might possibly be found on the lofty ranges beyond the Sutlej.

17. **Pieris napi ajaka.** Moore.

(Bing. 594 ; Ev. B 4 (7)).

Fairly common though not so abundant as the other two 'whites', *brassicæ* and *canidia*. These others are so common and ubiquitous that any insect of similar general appearance is often passed by casually and the local race of *napi* thus escapes notice.

18. **Pieris canidia canidia.** Sparrman.

(Bing. 593 ; Ev. B 4 (10)).

The 'small cabbage' is common everywhere throughout the spring, summer and autumn, but appears to be most plentiful after the monsoon.

19. **Pieris brassicæ.** Linnæus.

(Bing. 590. Ev. B 4 (11)).

This insect, the almost cosmopolitan 'large cabbage', is abundant from early spring to late autumn. Occasional specimens may even be seen sometimes on sunny days in the depth of winter.

20. **Aporia leucodice soracte.** Moore.

(Bing. 584 ; Ev. B 5 (1)).

Exceedingly common in May and June, but disappears entirely with the arrival of the monsoon and there is no autumn brood. It is particularly fond of the common wild barberry bushes round which it swarms.

* 21. **Aporia nabellica nabellica.** Boisduval.

(Bing. 586 ; Ev. B 5 (2)).

Has a range from Kashmir to Kumaon, and though I have never taken it myself, there is little doubt that it will be found in the Huttoo neighbourhood. Is rare at the best of times, and does not come below 8,000 ft. Usually a spring butterfly.

22. **Aporia agathon phryxe.** Boisduval.

(Bing. 587 ; Ev. B 5 (4)).

May be seen very occasionally in Simla itself, but is not plentiful anywhere in the district. All the few specimens I have taken in the area were found on the northern slopes of Kufri Hill on the road to Fagu. It seems to be on the wing only for a short period just before the rains.

Delias eucharis. Drury.

(Bing 571 ; Ev. B 6 (2)).

Very common from Garhwal eastwards, and I have taken it in Dehra Dun and seen one as far to the north-west as Lahore. It is not unlikely to be found, though rarely, in the strip of country between Kalka and the Sewaliks.

23. **Delias sanaca sanaca.** Moore.

Delias belladonna belladonna. Fabricius.

(Bing. 577 ; Ev. B 6 (4) and (5)).

I put these together as they are usually treated as one species. *Belladonna* is fairly common, and in May and June may often be seen round the blossoms of the horse chestnut which attract them irresistibly. A few specimens may also be taken later in September and October. *Sanaca*, which was considered a light coloured variety of the species, is much less frequently seen, but I took one or two on Kufri Hill in June. Both extend inland as far as Baghi and Kulu.

24. **Belenois mesentina mesentina.** Cramer.

(Bing. 581 ; Ev. B 8).

Very common in the plains and at low elevations in the outer hills throughout the year, especially in scrub jungle. Rather rare above 5,000 ft., but odd specimens may be picked up now and again.

25. **Huphina nerissa phryne.** Fabricius.

(Bing. 604 ; Ev. B 9 (2)).

More a plains than a hill insect. It is common during and after the rains at the foot of the hills. Occasional specimens find their way up as high as 8,500 ft., and I have taken it in Simla and Kufri.

26. **Catopsilia crocale.** Cramer.

(Bing. 622 ; Ev. B 11 (1)).

Abundant in the plains, and, though never as common as the next species, is generally to be seen in fair numbers in the hills up to about 8,000 ft. Mainly an autumn flying insect.

27. **Catopsilia pomona.** Fabricius.

(Bing. 622 ; Ev. B 11 (2)).

Usually sunk to the last species, but has now been definitely placed as distinct. Flies from May or June till late autumn, more abundantly after the monsoon. Has the same general distribution as *crocale* but is always more common. Females of the form, '*catilla*'—*Cramer*, with purple blotches on the undersides of the wings, are almost as frequent as the type.

28. **Catopsilia pyranthe.** Linnæus.

(Bing. 623 ; Ev. B 11 (4)).

Like the others of the genus, is more common in the plains and country round Kalka ; but it extends up the river valleys and sparingly as far as Simla and Mashobra. Is best looked for in open grass and scrub country.

* 29. **Catopsilia florella gnoma.** Fabricius.

(Bing. 624 ; Ev. B 11 (5)).

Recorded from the 'North-west Himalayas', but I have never seen it anywhere in North-west India, the nearest locality known to me being Lucknow. May yet be found in the Simla Hills.

30. **Gonepteryx rhamni nepalensis.** Doubleday.

(Bing. 624 ; Ev. B 14 (1)).

The Indian ' Brimstone ' is common in the spring and autumn, much less so in the intervening monsoon months. Found anywhere and everywhere above about 5,000 ft.

31. **Gonepteryx aspasia zaneka.** Moore.

(Bing. 629 ; Ev. B14 (3)).

Confined to higher elevations—above 7,000 ft.—and rather local though never scarce in the particular places it affects. I have taken it from June to October in various spots in Mashobra, Mahasu, Kufri and Narkanda. It is worth noting that I have often found that a *Cyaniris vardhana* area is also a *G. zaneka* haunt.

32. **Terias libythea.** Fabricius.

(Bing. 640 ; Ev. B 15 (1)).

Probably the most common of this group of common butterflies. Found everywhere—but most plentifully in open grass country—from the plains up to at least 10,000 ft. and from early spring to late autumn.

33. **Terias venata venata.** Moore.

(Bing. 639 ; Ev. B 15 (2)).

Not nearly so common as the last, but is probably usually overlooked among the many Terias to be seen.

34. **Terias laeta.** Boisduval.

(Bing. 641 ; Ev. B 15 (3)).

Almost as abundant as *libythea*. It flies at the same seasons and in the same kind of country and is generally very common about the low hills above Kalka in the summer.

35. **Terias hecabe.** Linnæus.

(Bing. 643 ; Ev. B 15 (5)).

This species is so ubiquitous throughout India and so common everywhere that its various geographical races seem to merge into one another almost imperceptibly and it is by no means easy to differentiate between them. The race *' fimbriata '—Wallace*, which has been assigned to North-west India, is ordinarily indistinguishable from the *' simulata '—Moore*, of continental India. One or the other will be found occurring commonly throughout the range of the district at almost any time of the year. It is more abundant in the autumn than in the earlier months.

* 36. **Colias ladakensis.** Felder.

(Bing. 631 ; Ev. B 16 (5)).

Recorded from Kashmir to Kumaon, but is a rare insect of the higher mountains. If found in the district, will be only on the lofty ranges of the interior.

37. **Colias hyale hyale.** Linnæus.

(Bing. 630 ; Ev. B 16 (7)).

This species and its variety *erate,—Esperance* and its female form *pallida,—Staudinger*, though not abundant, will be found fairly regularly anywhere above 7,000 ft. To get a really good series, one must exploit the open grass slopes of the higher hills, such as the plateau on Kufri Hill and the meadows round Narkanda and Baghi. Found from May to November and occasionally in the winter months.

38. **Colias croceus edusina.** Butler.

(Bing. 638 ; Ev. B 16 (11)).

No one who has given the butterflies even a passing glance can have failed to notice this brilliant little orange insect about the hillsides and amongst the wayside flowers of Simla. It is the only 'clouded yellow' which extends into the plains ; and it is common in the lower country in the winter months and in the hills all the year round.

39. **Ixias marianne marianne.** Cramer.

(Bing. 608 ; Ev. B 17 (1)).

Common on the plains and in the submontane tracts, rarer above 3,000 ft. A specimen or two may be picked up any day after the rains in the open grass lands around Simla. The bare spurs beyond Sanjouli and Mashobra are the most likely places.

40. **Ixias pyrene satadra.** Moore.

(Bing. 606 ; Ev. B 17 (2)).

Not uncommon in the plains and lower valleys to about 3,000 ft., but rarer in the inner hills. I have seen it in the Asni river valley and Col. Chaldecott took several near Luri on the Sutlej below Narkanda. Season as for *marianne*.

*41. **Colotis amata amata.** Fabricius.

(Bing. 648 ; Ev. B 18 (1)).

This species is fairly common in the central Punjab plains and one is said to have been taken near Ambala. There is just a chance that an odd one or two may be picked up below Kalka.

41. **Colotis etrida etrida.** Boisduval.

(Bing. 654 ; Ev. B 18 (5)).

Is also a species of the drier plains, but extends very sparingly into the fringes of our area at the foot of the hills.

Pareronia valeria hippia. Fabricius.

(Bing. 659 ; Ev. B 20 (3)).

I know of no record of this insect west of Dehra Dun, but it is not uncommon there, and there seems to be no reason why it should not occur in the similar country westwards along the foothills into the Kalka area. It will be rare but should certainly be looked for.

DANAIDÆ.

Though the Danais group of butterflies usually figure so prominently in Indian collections, none of the species of the family can be said to be really common in the Simla Hills. They are essentially insects of the plains and warm valleys, and though some of the species are fairly common at the lower levels of the hills in the north west, even these, as a general rule, become scarcer and scarcer as one ascends into the mountains. Only some eight species come into the district at all.

42. **Danais aglea melanoides.** Moore.

(Bing. 15 ; deN. 16 ; Ev. C 2 (1)).

We are almost at the extreme westerly limit of the range of this insect, and it is very rare here. It will occasionally be found along the foot of the hills, but does not go above 2,500 ft. I once got a very worn specimen in a nullah near Kalka in May.

43. **Danais tytia sita.** Kollar.

(Bing. 14 ; deN. 20 ; Ev. C 2 (5)).

Not very common but may be seen at intervals—oftener in the autumn than in the spring. Usually flies high in and around Simla, where I have taken it in June, September and October ; but is more abundant and more easily taken in the valleys of hill rivers.

44. **Danais limniace mutina.** Fruhstorfer.

(Bing. 12 ; deN. 26 ; Ev. C 2 (9)).

Very common in the plains and comparatively so in the country round Kalka, but seldom seen above 4,000 or 5,000 ft. Taken in the bed of the Simla river in September, and below Summer Hill in June.

45. **Danais melissa septentrionis.** Butler.

(Bing. 13 ; deN. 27 ; Ev. C 2 (10)).

This species shares with *D. tytia* a preference for the hills as distinct from the plains and is not likely, in the N. W. Himalayas, to be found below 4,000 ft., though its eastern and southern races descend almost to plains level. Any hyaline Danais taken round or beyond Simla is almost certain to be either this species or *tytia*. Usually found in open nullahs, but sometimes flies in the station and in grass country. Occurs both spring and autumn.

46. **Danais plexippus.** Linnæus.

(Bing. 6 ; deN. 31 ; Ev. C 2 (12)).

47. **Danais chrysippus.** Linnæus.

(Bing. 8 ; deN. 28 ; Ev. C 2 (14)).

Might conveniently be dealt with together. Both are common in the plains and in the low river valleys, less so at any elevation in the hills. *D. chrysippus* is generally the more abundant in the plains, but seldom goes very far into the hills ; while *plexippus* travels further afield and may not infrequently be seen in and around Simla, though I have not met it above 8,000 ft. Both prefer open surroundings and fly from April to October, but are more in evidence after the rains.

48. **Euplœa core core.** Cramer.

Euplœa core vermiculata. Butler.

(Bing. 31 ; deN. 61, 62 ; Ev. C 3 (15)).

Two local races of the typical *core*, distinguished only by the appearance of the white post discal spots on the forewings, which, in the former, tend to decrease in size towards the apex, and, in the latter, increase in size. Typical *core* is said to be the continental and plains form, while *vermiculata* is the Himalayan variety. Though, in a long series of insects, this distinction is abundantly clear, I have not been able to satisfy myself that either form is restricted to any particular area. Both may be taken within the country dealt with in this paper, *vermiculata* being very much the scarcer form. Taking them together, they are common in the plains and near Kalka, but markedly less so as one proceeds higher and are rare above 4,000 ft. A very occasional specimen may be seen in Simla in the summer and autumn.

* 49. **Euplœa mulciber mulciber.** Cramer.

(Bing. 46 ; deN. 56 ; Ev. C 3 (1)).

deNiceville has recorded this species from 'near Kalka,' and this is the extreme westerly limit of its range. Though so common in the Eastern and Central Himalayan foothills, it is rare even in the Mussoorie Dun, and its appearance here is very exceptional. Any that there are, would be found in the low valleys and ravines near Kalka.

(*To be continued*)

OBITUARY

JOHN C. ANDERSON

On the 17th June, 1930, John Coussmaker Anderson passed away at Ramsgate, aged 78, and there must be many old friends who remember him, although he left Bombay so long ago as 1901.

He was the son of General William Coussmaker Anderson and Caroline Cahill, and was born at Dharwar, Bombay Presidency, on 9th September, 1851. He was educated at Rugby and afterwards read at the Inner Temple, being called to the Bar in 1875. Three years later he went out to India and practised in the High Court at Bombay for 25 years. He married on his retirement from India in 1901. When he returned to England he made his home for ten years at Winchelsea, Sussex, where he was Mayor for a time, but in 1915 he moved to Ramsgate on account of his health.

J. C. Anderson was one of the eight original founders of the Bombay Natural History Society and as another old member writes, ' he was a keen lover of nature and helped the Society in many ways, years ago '.

In January 1889 he contributed an interesting Paper to the Journal (No. 1, Vol. IV) entitled ' Sporting Rambles round about Simla ', and presented to the Museum a large number of specimens of skins of birds and mammals collected by him round Simla.

He leaves a widow, three sons and three daughters to mourn their loss.

Although handicapped by bad health in his retirement, he devoted a great deal of his spare time to painting and derived much pleasure from this hobby.

A very lovable man, whose loss will be regretted by all those who were privileged to know him and their sympathy will be with his widow and family in their great bereavement.

W. S. M.

November, 1930.

REVIEWS.

I. THE GAME-BIRDS OF INDIA, BURMA AND CEYLON, (PHEASANTS AND BUSTARD-QUAIL) VOL. III—By E. C. Stuart Baker, O.B.E., F.L.S., F. Z. S., M. B. O. U., H. E. A. O. U., with 11 coloured plates and 9 black and white plates. 340 pp., John Bale, Sons & Danielsson, Ltd., London, 1930. Published by the Bombay Natural History Society.

During 1915 to 1919 Mr. Stuart Baker published in the *Journal* a continuation of his articles on the game birds of India and these have been brought up to date and are now published in book form.

This volume—number three of the series—includes the Hemipodes or Bustard-Quails—the Megapodes and the Pheasants, and will be of great interest to all sportsmen and naturalists in the East.

The first family treated is the *Turnicidæ* or Button-Quails, which includes three species, the Bustard-Quail, the Little Button-Quail and the Button-Quail.

Apart from certain anatomical differences, these little birds have a common habit in which they differ from all of the game birds in that the males incubate the eggs and bring up the young without the help of the female.

Of the Bustard-Quails no less than seven races are now recognized, while in his articles in the *Journal*, Mr. Baker only gave two. This increase in the number of recognized races is due to a careful revision of the group in conjunction with the late Mr. H. C. Robinson.

The colour differences which distinguish these races were many years ago pointed out by Mr. W. R. Ogilvie Grant, who attributed them to the variation in the rainfall in the different localities, but probably that is only one of the many causes.

The Little Button-Quail, Mr. Baker considers a good species, but we are rather in favour of Dr. Stressman's view that it is a race of the common Hemipode of Europe *Tarmix sylvatica*, of which there are various races in Africa.

Of the Large Button-Quail two races are allowed as before, but unfortunately there has been an inevitable change of name and the Burmese subspecies is now known as *Turnix maculatus maculatus*, instead of *Turnix tanki blanfordi*.

The next birds to come under review are the Megapodes of which we have two races, the one in the Andamans and the other in the Nicobars. Here again we have birds with very different habits from either the game birds or the Hemipodes, and instead of incubating their eggs, they deposit them in prepared mounds of dead leaves where they are hatched by the heat given off by the decaying vegetation. The young when hatched can fly, and apparently the parents take no interest in them.

Since the account of the Peacock-Pheasants appeared in the *Journal*, these birds have been revised by Dr. P. R. Lowe, who found that a hitherto unrecognized race inhabited the area between Sikkim and Manipur. The display of the Argus Pheasant is well illustrated by a photograph taken in the London Zoological gardens by Mr. Seth Smith, but there is no mention in the description that the male watches the female through the angle formed by the wing,—a fact which was first demonstrated by Mr. Seth Smith.

The account of the habits of the Red Jungle-Fowl by Mr. Baker and of the Grey by Davison are very complete and make interesting comparison. We now come to the pheasants but the only true pheasant found within our limits is ***Phasianus elegans***, Stone's Pheasant, though Mrs. Hume's Pheasant and its Burmese race are very closely allied, but are now kept in a different genus *Syrmaticus*, on account of the feathers on the rump being short and rounded instead of long and disintegrated, and there are certain other small but constant differences. These birds are confined to the Eastern portions of our region.

The account of the Cheer and Koklas Pheasants will be of more general interest since, with the exception of Mayer's Koklas, they all inhabit the

Himalayas, but why the last is included we do not quite understand since the distribution given 'Yerkalo, Upper Mekong to Central Tibet' can hardly be said to be within our area.

The beautiful Amherst Pheasant has occurred in the Myitkyina District but it is strictly speaking a Chinese bird, while the Fire-back, called Vieillot's Fire-back Pheasant, in the *Fauna*, is found in the extreme south of Siam, and the Siam Fire-back Pheasant just comes into our limits in the South Shan States.

From the Indus to China and as far south as Tenasserim and Indo-China there is found a heterogeneous collection of pheasants belonging to the genus *Gennæus*, which are known as Kalij or Silver Pheasants. These birds in certain areas, the Himalayas, Assam, China, Indo-China are separable into several species and numerous races, that is to say in certain districts the pheasants are all of one type. In certain parts of Burma, however, there is a very different state of affairs, and except in Arrakan and Tenasserim, there are really no distinct types but all manner of mongrels. In the British Museum, there is probably the largest collection of these pheasants anywhere, but it is totally inadequate to solve the problem of the Silver Pheasant in Burma. Residents in that country could do much towards clearing up the question of the Silver Pheasant if they would carefully collect specimens with full particulars as to the common type in their district and whether the different types consort and breed together. Mr. Baker, we think, has made the best of a bad job with the existing material and considers the Kalij and Silver Pheasants to belong to six species, though he cautiously suggests in his definition of the genus *Gennæus*, that perhaps ultimately we may have to consider them all belonging to one species with numerous sub-species.

There are few birds more beautiful in colour than a male Impeyan Phesant or Monal, and we are glad to learn it is still common in the Himalayas. In the past large numbers were killed for their skins and we have seen boxfuls confiscated by the Customs. According to Mr. C. H. Donald, the trapping of this bird still goes on and we suppose some consignments evade the Customs and reach some Continental market, but we are certain very few are now smuggled into London, and doubt very much if London dealers have anything to do with the trade as Mr. Baker rather suggests.

We can strongly recommend the volume to members, and considering the wealth of illustrations, it is cheap as bird books go nowadays.

Mr. Gronvold and the printers are to be congratulated on their share of the work.

N. B. K.

II. THE FORMENKREIS THEORY AND THE PROGRESS OF THE ORGANIC WORLD.—By Dr. Otto Kleinschmidt. Translated from the German by the Rev. F. C. R. Jourdain, M.A., M.B.O.U., F.Z.S. 192 pp.; with 16 plates from photographs and numerous text-figures. London (H. F. & G. Witherby). Price 10s. 6d.

In this book (originally published in German in 1926) the author who is a clergyman as well as eminent German ornithologist, attempts to show that the old Theory of Evolution is all wrong. He claims that his own theory, which he here offers instead, and which according to him is essentially a 'recasting of the old Evolution Theory', upholds 'the indications found in nature as to independent sources of life in opposition to the theory of a common origin for all life'. He contends that the evidences hitherto cited in support of the theory of descent of all life from the protozoon—Palæontologic, Embryologic, by Blood serum tests and others—are entirely misleading. Among other things he denies the possibility of birds having been derived from reptilian stock, and gives his reasons for discrediting the belief that the Archæopteryx was the probable ancestor of our present day birds. He maintains that in the theory of Recapitulation the seeming phylogenetic resemblances in embryos has been grossly exaggerated. He asserts that species cannot be derived from races, and in short, the existence of so many different forms of animal life on the earth seems to him accountable only on the assumption of there having been so many independent creations.

The author explains at the outset that the idea of Formenkreises or 'Form circles' is no innovation of his; it was first suggested by the celebrated philosopher Kant as early as 1775. Indeed the term 'Formenkreis' itself is not new to zoologists either, but it has hitherto been employed—principally in Entomology and Malacology—in a slightly different sense to that now assigned to it by Dr. Kleinschmidt. The former used it merely to denote a group of geographical forms or races and as such therefore it may be considered synonymous with what is more commonly known to us to-day by the term 'Species'—a unit capable of being split into a number of geographical races or sub-species, or conversely, comprising all such. To take an example near home, our Indian House Sparrows *Passer domesticus indicus*, *P.d. nigricollis* and *P.d. parkini* are all treated by us as belonging to the same Species, or in the sense of the term as used before Dr. Kleinschmidt's resuscitation of it, they would all be considered geographical forms of the Formenkreis *Passer domesticus*. Between the term as used above and the significance now attached to it by Dr. Kleinschmidt there is an intrinsic difference Dr. Kleinschmidt does not only lump geographical *races* under this term, but all forms which he considers to be geographical *representatives* ot one another, even where these have been differentiated as Species from Miocene times! He widens the limits of each allied group 'of independent origin' to 'an inconceivable extent'; in other words his 'Formenkreises' include much more than mere geographical races.

The author lays stress on the fact that for different forms to belong to a single Formenkreis two essential conditions must be satisfied, viz.: (1) the forms must exclude each other geographically, and (2) they must replace each other. These seem to us to be more or less the identical conditions required for what are known to us as Geographical Races! In order to make his meaning clearer the author explains: 'A Herring and a Zebra exclude each other geographically. The last lives on the African Continent, the former in the North Sea' (p. 34). and since the Zebra does not replace the Herring as the various species of Herrings do each other, the Zebra and the Herring belong to two different Formenkreises. Well and good. But among the carefully selected examples of Formenkreises which are given (the truth of some of which, as for instance the Marsh-and Willow-Tits among birds, has already been accepted by systematists) when the assertion is made that *Passer domesticus* and *P. hispaniolensis* belong to the same Formenkreis in spite of the fact that in many areas the two species ('forms' according to the author) are found breeding side by side thereby distinctly contravening one of the fundamentals above stated (viz., 'Formenkreises can exist side by side, races exclude each other geographically'), we fear the author's explanation for this discrepancy will not be generally accepted.

According to the Formenkreis Theory it seems it is not necessary for the geographical replacement to be able to show all its existing connecting links, and there may be extensive gaps in the distribution of two apparently quite different forms which may nevertheless belong to one and the same Formenkreis. To make the author's implication, as we understand it, clearer, we shall take a hypothetical case. Readers will recall the interesting paper which recently appeared in this Journal (vol. xxxiv, pp. 754–71) on the Origin of Continents and Oceans according to Wegener's Displacement Theory. Well, suppose the Formenkreis of a certain bird existed over Brazil and West Africa at a time when the two continents were united along their edges. When the land masses drifted apart, their fauna was also naturally split up, but in spite of this one would expect to find birds in Brazil and West Africa to-day belonging to the same Formenkreis, though having been separated for such a lengthy period, the two forms may now have become quite unrecognizable as such. They may perhaps even be classified by our systematists under totally different genera, whereas a careful examination of their skeletal characters and natural affinities, it is claimed, would show them as belonging to the same Formenkreis! The Seal of Lake Baikal is cited as an example more or less of this nature, its presence there being only accountable by the fact that Lake Baikal was formerly connected with the northern oceans by an unbroken stretch of sea. Both the seals, though widely separated and living in areas not at present subjacent to one another, apparently belong to the same Formenkreis. The Seals of the Caspian could, we imagine, also be cited as an example of this kind.

We rather think that the author has contradicted himself in this interesting suggestion. If he can conceive (as we gather) that isolation and milieu may bring about changes in an organism of the magnitude suggested in our hypothetical case (viz., to render classification into a totally different species or even genus necessary) why will he not allow us to conceive that under given conditions Species may develop from Races and from one another, or—to carry the thing to its logical conclusion—that all beings may have evolved from a common origin? The author, however, definitely seeks to prove throughout his work that Species have not been derived from Races and from one another as is commonly believed to-day, but must be the result of so many original creations! Unfortunately many of his arguments seem to us rather far-fetched and not altogether convincing, and we must confess that in the present state of our knowledge his stand appears to us only justifiable by the fact of his being—in spite of his scientific outlook and attainments—essentially a theologian of the old school.

In the course of his book, Dr. Kleinschmidt suggests a new system of trinomial nomenclature based on a recognition of Formenkreises as defined by him. We can only hope that he is not in earnest as, in our opinion, its adoption at this stage can only lead to making confusion more confounded than ever!

On the whole, Dr. Kleinschmidt's book is interesting reading and furnishes a wealth of arresting and thought-provoking material which the author has laboriously collected in the course of the last twenty-seven years during which he has been engaged in elucidating his theory. Though we may not be able to see eye to eye with him in all that he has to say, we cannot but admire the learning and industry which have enabled him to formulate his theory, and his courage in exposing it to the almost certain hostile fire of what he considers sceptical and biassed people.

Dr. Kleinschmidt's style is unfortunate. In places it is unnecessarily pompous and dogmatic and extremely difficult to follow unless read and re-read over and over again. On laying down the book one is left with a lurking suspicion that there may really be more in his theory than has caught the eye. Clarity has not been enhanced by the translator's effort to ' reproduce in English the exact words of the author, not amending or altering the text in any way, but preserving as far as possible the characteristics of the writer ' (p. 15), although in fairness to the translator we must confess it would have been extremely difficult to render a work of this nature faithfully in any other manner.

S. A. A.

III. AN INTRODUCTION TO ZOOLOGY.—By P. W. Gideon with illustrations. 88 pp. Student's Own Book Depôt, Dharwar, 1930.

Prof. Gideon's Introduction to Zoology is a publication primarily intended for the use of the Intermediate Science Examination students of the Bombay University, who study a few types of animals representative of some of the principal phyla in Zoology. He has prepared the book with this intention and incidentally tried to condense in it as much information as possible about systematic Zoology in connection with those phyla in the form of charts or tables. He has succeeded well in accomplishing his first object, inasmuch as facts relating to the type-animals are given in a most terse manner which the students will find easy to follow. But beyond this there is nothing special or original in the treatment of the subject to attract attention, nor is any new piece of information of an original kind embodied therewith.

In the fulfilment of his second object of imparting knowledge about zoological classification it may be said that he has fallen short of it. Without brief and proper explanatory discussion on the classification of the phylum given in each chart as a preface to it, the chart by itself will not appeal to the student and the students are very likely to overlook these charts. The book is thus one more addition to the host of such elementary publications. However, on the whole the book has been most carefully prepared. The illustrations are all well drawn and executed, but they all appear to be familiar figures from various standard books.

Moreover, at page 3, the author gives the chemical composition of proteins as formed of C. H. N. & O. only which is not proper. No protein compound exists without traces of S. being present in addition to the above elements. No hints for the practical work are given which is rather unfortunate.

V. N. H.

27th October, 1930.

AN OPEN LETTER TO THE EDITORS

A perusal of several recent articles in the *Journal* has induced me to write on a matter of considerable importance to the study of Ornithology. We are face to face with a danger which has arisen in most countries but at the moment is particularly evident in India. I refer to the indiscriminate use of subspecific or racial names.

It is easy to see how this danger has come upon us. The progress of Indian Ornithology has hitherto been one of fits and starts, of periods dominated by the work of outstanding authorities; each of whom in turn gave an impetus to the study and finally became, through no fault of his own, something of a stumbling block. Jerdon, Hume and Blanford and Oates each in turn summed up the Ornithological work done in India and each in turn retarded it as their writings grew out of date and yet retained the confidence of a circle of field naturalists working in a land far from the centres of scientific thought.

When I arrived in India and started to work on Indian birds, my constant guide, companion and friend was found within the covers of the four volumes of Blanford and Oates, which we now term the *Old Fauna*. My case was the same as dozens of others. We turned to the *Fauna* for each new bird that we met with. We accepted its dicta with complete and justified confidence. We catalogued and inscribed our eggs and skins with the serial number of the species in the *Fauna*. We corresponded with each other according to the names and numbers of the *Fauna*. Occasionally with triumph we hailed a small discovery of some fact which was ' not in the *Fauna*' and we immediately wrote to the *Journal* about it. The result was that we in India attained for a time the millennium of all good Zoologists—uniformity of Nomenclature.

Then we gradually awoke like Rip Van Winkle. We found that the world had passed us by. We were writing and talking a language that to the rest of the Zoological world was becoming archaic. There were people who smiled at us when we wrote to them about No. 1 *Corvus corax* and they said that they supposed we must mean *Corvus corax laurencei;* or was it *Corvus corax tibetanus* to which we referred? We answered loftily about the views of the *Fauna*, and they were quite unimpressed and capped us with Hartert.

Looking back now I remember my own struggles against this clumsy unsatisfactory new system of trinomials, new to me at a time when science in Europe had entirely accepted it; and chief of my arguments was that it could not be made to square with my bible, my *Fauna*. It is amongst the many debts which I owe to the present Editor of the *Ibis* that he patiently struggled with my doubts and hesitations and at length led me to understand the virtues of the new system. I accepted it at last and painfully annotated my *Fauna* with the aid of Hartert's great work, endeavouring to reconcile the old and the new. Looking back through the past volumes of the *Journal* I see that I was the first to introduce a trinomial into the serried ranks of *Fauna* names and *Fauna* numbers : and naturally enough I was attacked for helping to upset the good *Old Fauna* names.

However that is all past history. The present is with us and that includes a *New Fauna* complete with trinomials. Now the point of my letter appears. An ornithological public in India is proceeding to treat the *New Fauna* as they treated the old. It is to provide a standard catalogue into which all the birds of India are to fall in neat compartments, ticketed and docketed and filed with the precision of a Government office. If ornithological science in India is to prosper, this tendency requires to be stopped at once and the author of the *New Fauna* would be the first to agree with this.

It is necessary first of all to explain the reason why there should be such a difference between the treatment of the *New* and the *Old Fauna*. And then I will show the harm that will result if the difference is not recognized.

Now the unit of treatment in the two *Faunas* is different. In the *Old Fauna* it is the species, in the *new* the subspecies. The species is a unit about which there is on the whole very little doubt. There are exceptions of course but on the whole there is very little difficulty to a moderately competent ornithologist over the recognition of species from a book. In the *Old Fauna* a keen, working ornithologist could probably recognize 90 per cent of the species from the written descriptions. Recognizing species alone, the *Old Fauna* disregarded minor distinctions. Under No. 1 *Corvus corax*, Oates grouped (with slight heart-searchings no doubt which often led him to comment on the points) the largest race of the Raven, the fine bird of Tibet, with one of the duller smaller races of the desert. It was not difficult for the egg-collector who knew his Indian birds fairly well to settle on the balance of knowledge and description and probability that the nest he had found belonged to a Raven. And this division held good whether he found his nest in Tibet, in the Punjab or some obscure outlying region of the North-West Frontier. It was a Raven's egg and that was all he wanted to know. A higher authority had settled that although Ravens in these areas might differ *inter se* the point could be disregarded.

In similar cases the difference might be larger and then the authority decided that the point was to be recognized and a second species was duly chronicled : but here again it was fairly safe on the balance of descriptions and possibilities to fit the bird or its egg into its appropriate division. In due course the keen student wrote his paper for the *Journal* on the birds of his district and it was fairly safe for the reader and collator to assume that 90 per cent of the birds were named with their appropriate names. The divisions were wide enough to give a high margin of safety.

With the *New Fauna* all this has changed. The unit is the subspecies and the subspecies is a far narrower compartment or pigeon-hole into which to fit one's observations. Take the case of the Common Grey Tit of India for instance. In the *Old Fauna* we were provided with one species which we called *Parus atriceps*. It was easy to recognize in the cabinet and in the field. There was nothing like it in India. Seen in Kashmir or the Nilgiris it was immediately recognizable—beyond all doubt if the view was clear and the observer competent—and immediately one's notes could be placed confidently in their appropriate division without a care for minor differences which our *Fauna* had stated, were negligible.

Now it is far different. The *New Fauna* has given 5 sub-divisions of our old division, for India proper alone. For each of those sub-divisions, that is races, it has given a diagnosis and a distribution. The Indian Ornithologist is immediately proceeding to behave in the face of these five races as he behaved with the old *Parus atriceps*. He is a little bothered by the fact that he has five pigeon-holes instead of one and reading the differences between the races he finds them hard to visualize and perhaps to fit in with his actual specimens. But he duly decides (with an eye on the distribution) that his bird is probably of such and such a race and in due course proceeds to chronicle it as such. The result is that in many of the recent numbers of the *Journal* many racial identifications appear which are certainly wrong and far more that are probably so.

If this continues, there will be only two possible results, for papers are set on record as contributions and aids to future work. The next writer who proceeds to use these papers as a basis for further writings and collations, will, if he is unwary, accept these wrong racial identifications and piling Pelion upon Ossa build up a structure which will prove entirely useless and incorrect. Or, if he is wary and has the necessary knowledge he will soon spot the number of wrong racial identifications and finally be compelled to reject almost everything, through sheer inability to sort the correct from the incorrect.

The author of the *New Fauna* is the first to acknowledge that the information in the new edition is not beyond dispute. He says himself that he regards his volumes as the starting point for fresh work, and that plenty of it remains to be done. The material is not yet available for a complete account of the birds of India to be written. The *New Fauna* has suggested *in the light of available evidence* a system of races or pigeon-holes into which Indian birds can be distributed. But we must remember that with the exception of Sind, the Punjab, the Himalayas and the Bombay Presidency, there is no part of India in which any material number of specimens have been added to the Hume collection now 70 years old. The *Old Fauna* was based on the material in the Hume collection ; to-day in the British Museum workers turn over the same skins which Hume collected with little else to supplement them. The whole of the eastern side of the Madras Presidency, Mysore, the central plateau of the Deccan and Central India, and Central Bengal are still virtually unknown to us in an ornithological sense, whilst numerous smaller areas require to be worked. It is clear therefore that no arrangement of subspecies provided in the *New Fauna* can be regarded as a final arrangement.

To remedy this state of affairs the Society arranged with the generous aid of Mr. Vernay to send out the survey of the Eastern Ghats. Working out this collection with Mr. Kinnear, I have already seen how many forms require revision, both in regard to their races and their known distribution. In the first family of the *Fauna*, the *Corvidæ*, for instance we have made two discoveries; that the Indian Tree-Pie, one of the commonest and best known of Indian birds, needs yet another race *vernayi* in addition to the race *pallida* which Mr. Stuart Baker himself has added in Vol. VII to his original treatment of the group; and that the Himalayan Tree-Pie is represented in the Eastern Ghats by a new and common race whose existence there was not even suspected by the ornithologists of to-day. Yet in both cases the authors of the recent papers whose practice I am deploring if they had been collecting in the Madras Presidency would have doubtless identified their specimens of these magpies by the trinomial names already in Vol. I of the *Fauna*. We should have then seen the absurd situation of the small pale Tree-Pie of Madras being called by the name of the large dark Bengal bird *vagabunda*; whilst the tropical, fever-ridden jungles of the Northern Circars would have been credited with an East-Himalayan race of a wider spread species. What is the use of such work and records?

There is a further point. Many geographical races differ in details which are not easily apprised from a written description. *Chloropsis aurifrons aurifrons* and *Chloropsis aurifrons davidsonsi* are easily distinguished from a written description through the presence or absence of certain markings. *Emberiza cia stracheyi* and *Emberiza cia par*, on the other hand would never be safely distinguished by a field naturalist with one bird in his hand and merely the book to guide him. With both races before one, the first glance shows their distinctive paleness and darkness but comparison cannot be attained without the presence of the standard. Yet there are many other good races, and several species, which no one can claim to identify without careful comparison or great experience. In our survey series from the Eastern Ghats, common birds like the Quaker-Thrush (*Alcippe poioicephala*) and Horsfield's Scimitar-Babbler (*P. horsfieldii*) have given us endless trouble to identify even subspecifically with a large series of each obtained by the Survey and the big series in the British Museum for comparison.

There is a third cause for error, namely, the tendency of birds to migrate or wander. If we merely identify our races by guess-work, we lose the chance of learning all those details of migration and migration routes which the study of subspecies is most especially likely to furnish.

In the *Old Fauna*, *Emberiza stracheyi* was said to migrate to the plains of the N.-W. in India. When I was posted to the Jhang District some years ago I found a Bunting common there in winter and at first accepted it as being *stracheyi* come down from the Himalayas in winter, according to schedule. I collected a few specimens and took the trouble to compare them with my specimens from Simla. They were very different and hunting about in the pages of Hartert, I learnt about *E. c. par* which my birds were verified to be. Starting with this information I have since learnt how there is considerable migration of this Bunting from west to east in place of the north to south migration assumed in a day when geographical races were not recognized.

To take another instance. Some years ago I wrote an account of the migrations of the Pied Crested Cuckoo (*Clamator jacobinus*) appealing for data so that we could find out whether the myriads which appeared in Northern India in the rains wintered in the South or in Africa. The specimens procured in the Eastern Ghats survey prove to belong to the Ceylon race *taprobanus*, a point which virtually settles that our Northern migrants go to Africa.

To recapitulate briefly, the state of our knowledge renders it very unsafe to identify the race of any Indian bird by guess-work from a perusal of the *Fauna*. The fact that our knowledge of the distribution of Indian birds and their races is incomplete ; the fact that races are often recognized only with skilled knowledge and comparison ; the fact that on migration, birds wander into the territories of other races of the same species ;—these facts all combine to render guess-work and deduction very liable to error. That being so, one must ask the question what is the value of subspecific identifications made without satisfactory reasons. There is only one answer and that is *none*. And I go further and assert that every identification of this type is worse than useless ; it is definitely harmful for it not only may lead us definitely astray on matters of fact ; while an accumulation of such identifications in literature will land us in a morass of error, throwing suspicion on good and bad alike, and it will take a generation or more to put our knowledge straight again.

Destructive criticism should always be accompanied by advice. So I now propose to suggest the lines on which our members should write their papers.

The ideal Scientific paper on the birds of a particular district would be one in which all specific and subspecific identifications were based on an actual examination of specimens procured in that district. It is not necessary that these specimens should all be collected by the writer *de novo*. If I set out to write a full account of the birds of the Nilgiri Hills for instance, I could base the greater part of my identifications on the fine series collected by Davison sixty years ago and available in the British Museum. I could supplement it with an examination of other specimens now in the Calcutta Museum, in the Society's collection and in many private collections. Doubtful points I could clear up by collecting a few birds myself, and the more thorough and painstaking my work and my use of existing material, the fewer birds I should need to kill for my purpose in an area which had been adequately worked in the past. On the other hand if I were stationed in some virtually unknown and unexplored area on the Burmese frontier I should need to procure specimens of almost every species, neglecting only those well-marked forms of which there could be no possible doubt of identification, assuming that I already had a good knowledge of my subject.

Between these two extremes we have to fit the circumstances of our particular district. The purpose is to know what species and race we are writing about, and as completeness is never possible, it is essential to make it clear to others what degree of completeness has been attained. This is done in various ways. Some writers list or mention the number of specimens they have been able to examine. Others affix an asterisk to the names of all species and races of which specimens have been procured and examined. Others use a binomial in general and a trinomial where actual specimens have been identified, that is to say they do not mention the race or subspecies without definite grounds on which they have satisfied themselves as to the correctness of their sub-specific identification. The method matters not; all that is necessary is to leave as part of your record an indication of the value of your record. If you have collected no specimens in verification, say so but do not list all the subspecies by guess-work. Your paper can still be of value in other ways.

The matter of course requires to be treated with the usual leaven of common sense and appreciation of circumstances. If I were to tour through six or seven districts of the Punjab in the spring and all the way I came upon Grey Shrikes breeding I should accept them all as *Lanius excubitor lahtora* without a shot fired. My knowledge of previous identifications of this breeding shrike in this area, confirmed by the *glassing* of occasional birds to verify the presence of the black wing coverts would be sufficient. But Grey Shrikes met at this season on the frontier hills obviously on migration would require and receive a very different standard of proof before I published any trinomial identification. To assume or to guess in their case, would be a very different matter. Yet here, too, I should gradually be able to relax my standard if my posting were in some frontier fort where the careful individual identification of one year could relax with the growing familiarity of spring after spring.

And here a word of caution is necessary. One often reads that a bird was shot and identified with the *Fauna* but the specimen was not kept. Such an identification is far from settling a disputed point. Mistakes occur and often outrageous ones—I have had the skin of a 'Crested Lark' sent me to confirm a record of nest in an area where no crested lark should be; yet when the parcel arrived, it contained a Crested Bunting, perhaps the most destructive of all Indian birds and which had merely the crest in common with the lark (and fifty other birds). Shoot a Meadow Bunting across the border in Afghanistan and compare it with the *Fauna* description, yet unless you have already studied the point and know it, you will not safely identify your bird either as *par* or *stracheyi*, not safely enough that is to base some new fact or distribution upon it. So if you have shot your bird for the record, make a skin of it for future verification; if you cannot skin in the correct manner split your bird from chin to chine and pull off the skin as a flat one. If you cannot do that, cut off the wings and tail and legs and put them in an envelope. Then the record can be verified.

I hope I have made it clear that it is possible to write and write usefully on the birds of an area without killing a single bird. The measure of the value of such a paper lies in the honesty of the writer. If he makes it clear how his identifications were arrived at in general terms, and expands this into an explanation of the grounds on which he bases unusual records, it is then possible for the student of wider areas to assess the proportionate value of the records, taking the satisfactory ones and rejecting the unsafe. But let the student once assess the writer as untrustworthy (through lack of knowledge or want of care) and he will probably reject the paper *in toto*.

And so with the writer of short miscellaneous notes, who should use the binomial unless he has definite reason to use the trinomial. Each of us comes across interesting incidents which we wish to record, the Red-vented Bulbul's behaviour in our verandah, the unusual clutch of eggs and so forth. If we really know the subspecies to which we are referring that is all to the good and should be recorded. But if we are deducing the subspecies by the geographical position of our verandah, we had far better leave that deduction to the reader and let him be responsible for the further use he makes of it. We should set down just so much as we know, or if we deduce we should make it plain that we deduce, and then our contribution to knowledge will be exact and free from error.

And now, Sir, I must apologize to you and the readers of our *Journal* for so long a homily, but unless our members realize that the *New Fauna* has introduced a more precise type of scientific nomenclature to Indian Ornithology and that for this reason they must draw a distinction between their treatment of the *New* and *Old Faunas* we shall find ourselves in India in a hopeless muddle which will delay all further progress. It is not an imaginary evil which I am describing. The first fruits of it have already appeared in more than one recent paper which it is hardly fair to specify more exactly.

CALDBEC HOUSE,
BATTLE,
23rd January, 1931.

HUGH WHISTLER.

THE FOUNDERS OF THE BOMBAY NATURAL HISTORY SOCIETY.

It may be of interest to put on record in the *Journal* the origin and early history of the Society.

The Society was formed on the 15th September 1883 by, I believe, eight residents of Bombay whose names were :

Dr. D. MacDonald
Mr. E. H. Aitken
Col. C. Swinhoe
Mr. J. C. Anderson
Mr. J. Johnston
Dr. Atmaram Pandurang
Dr. G. A. Maconochie
Dr. Sakharam Arjun

In the proceedings of a Meeting of the Society held on the 22nd April 1902, (Vol. XIV, page 408), the late Mr. Aitken in referring to the approaching retirement of Dr. D. MacDonald, said, 'probably few of those present knew the real origin of the Bombay Natural History Society, or had any idea that Dr. MacDonald was the *fons et origo* of the whole thing. But such was the fact. It was early in 1883 that Dr. MacDonald suggested that it would be an excellent thing to form a Society for the study of Natural History.'

Mr. Aitken then mentions that six gentlemen met in the Victoria and Albert Museum and constituted themselves the Bombay Natural History Society. The six names he mentions are those given above but he omits the names of Col. C. Swinhoe and Dr. Sakharam Arjun.

In the Introduction in the first number of the *Journal*, January 1886, it is stated that the Society was founded 'by seven gentlemen interested in Natural History, who proposed to meet monthly and exchange notes, exhibit interesting specimens and otherwise encourage one another', but unfortunately it does not mention the names of the seven. The eight names given above were traced from the earliest Minute Book of the Society.

As No. 1, Vol. I, of the *Journal* may not be readily available to many present-day members, it may not be superfluous to quote further from the Introduction. The name of Mr. H. M. Phipson was not amongst the original founders, as I believe he was on leave in England at the time, but he must have joined the Society very soon afterwards, as the Introduction states :—

'For several months meetings were held in the "Victoria and Albert" Museum, but in January 1884, Mr. H. M. Phipson kindly offered the use of a room in his office in the Fort. This removal to a central situation gave an astonishing impulse to the Society. The meetings were better attended, the membership increased and collections began to be made, so that in a very short time the necessity for more ample accommodation was pressingly felt. The committee appointed to seek for suitable rooms having failed elsewhere, recommended the Society to ask Mr. Phipson to let one-half of his office premises, including the room of which they had up to this time had the gratuitous use. He consented to this and so the Society continued to hold its meetings and keep its collections at 18, Forbes Street. Its progress was so rapid however, that these premises were soon felt to be too small and last month the collections were removed to larger and in every way more suitable rooms at 6, Apollo Street.'

It is well known that Mr. H. M. Phipson was the backbone of the Society from March 1886,—when he took over the position of Honorary Secretary from the late Mr. E. H. Aitken—to 1906, when he left India, and the success of the Society has been greatly due to his devoted labour on its behalf, and his wonderful personality, aided by other stalwart early members, such as the late

Mr. E. H. Aitken
Dr. D. MacDonald
Mr. Justice H. M. Birdwood
Mr. R. A. Sterndale
Mr. G. W. Vidal, C.S.
Mr. J. C. Anderson
Surgeon K. R. Kirtikar
Mr. W. F. Sinclair, C.S.
Rev. F. Dreckmann, S.J.
Mr. R. C. Wroughton

all of whom have passed away, but their work is evident as shown by the present flourishing condition of the Society, which has been so ably helped by so many past and present workers whose names are too numerous to mention in this brief note.

Mr. H. M. Phipson is, fortunately, still with us, living in England, and continues to take a great interest in the work of the Society.

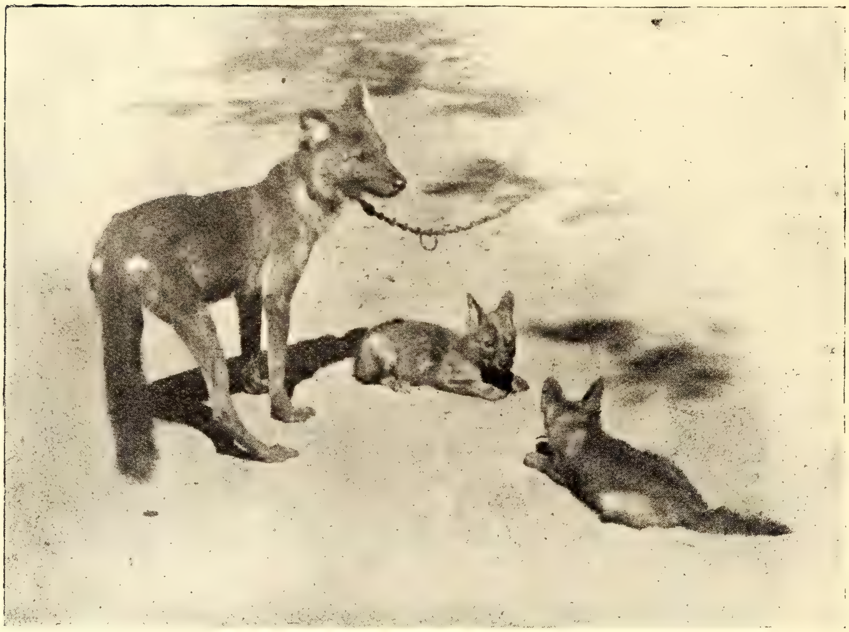
TUNBRIDGE WELLS, KENT, W. S. MILLARD.
November 1930.

[It may be interesting to members to note that the original rooms used by the Society in 18, Forbes Street, still form part of the Society's premises. They are now used for the Taxidermy work of the Society. Mr. Millard is a link with the old founders. He joined the Society in the year 1888 and working in close collaboration with Mr. H. M. Phipson whilst he was in India he carried on his work as Honorary Secretary from the time of Mr. Phipson's retirement until the time came for him too to leave India—in April 1920. He has, however, continued to be an active official of the Society and as our London representative has lessened the labours of and earned the gratitude of the EDITORS.]

MISCELLANEOUS NOTES.

I.—A CASE OF HYBRIDIZATION BETWEEN THE WILD-DOG AND THE JACKAL.

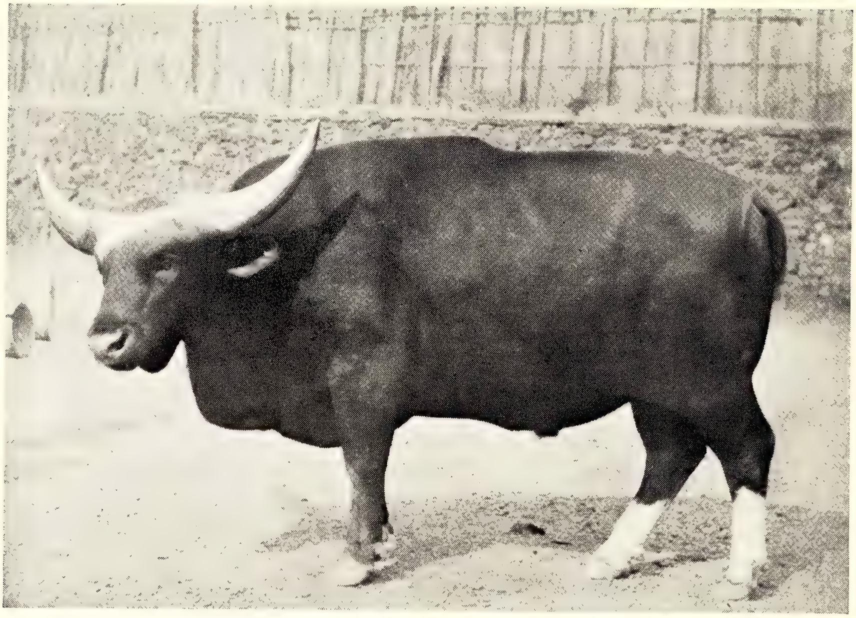
(*With a photo.*)



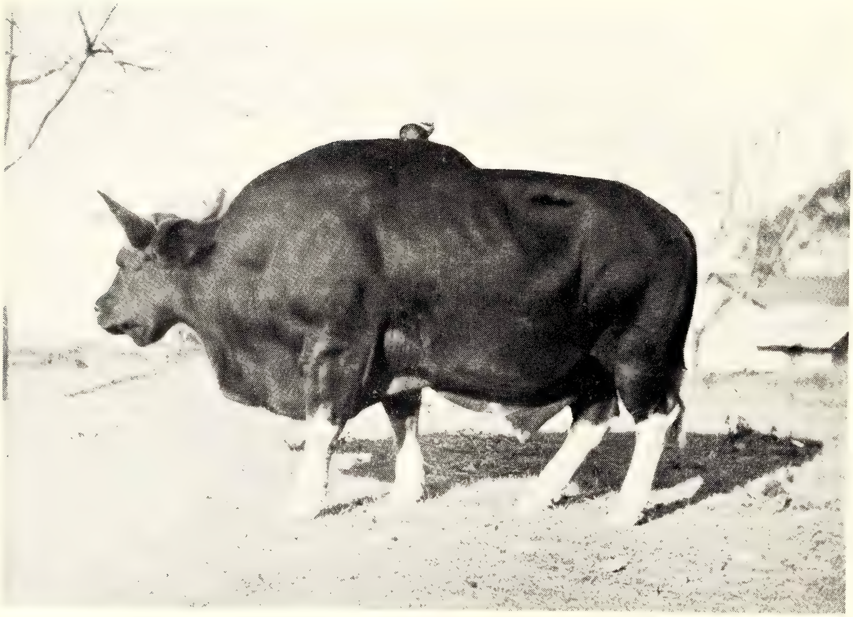
I am sending you a couple of snapshots that might interest your readers. At the Mysore Zoo, there were seven wild dogs at one time and as constantly many fights would ensue, they had to be separated. Owing to the limited number of cages and also to a certain extent as an experiment, a bitch was put together with a jackal in one cage. In due course intimacy was noticed between the two and on November, 27, 1930, two young pups shown in the photos were born. The mother is very good and looks after the young ones very well. The pups at present resemble the mother very much but it is yet too early to judge and take notes.

THE PALACE, MYSORE.
February 13, 1931.

SADEG Z. SHAH,
Assistant Secretary to H.H. the Maharaja of Mysore.



A fine bull of the Mithan (*Bibos frontalis,* Lamb.).



Mithan (*Bibos frontalis,* Lamb.) showing dewlap and dorsal ridge.

[In vol. xx, p. 215 of the Society's *Journal*, Maj. H. W. Berthon describes an incident of a Jackal hunting with Wild Dogs. The Jackal was an accepted member of the pack which attacked a goat tied up for bait. The Jackal was shot and its skin and skull sent to the Society's museum where it was identified as a true Jackal. Maj. Berthon suspected that the Jackal was a hybrid. In vol. xxx. of the *Journal*, the late Mr. Tuggersee, D.F.O., Kanara, published a note on a hybrid Jackal and domestic dog.—EDS.]

II.—LARGE HEAD OF MALAY SAMBHAR

(*CERVUS UNICOLOR EQUINUS*)

I am in possession of a sambhar head shot in the Thayetmyo District the measurements of which I give below:

The head is a very massive one but I am aware is not a record by any means when compared with some of the heads procured in India. For Burma, however, it is large, at least I have never seen one approaching it in size.

I would be glad if you would let me know if it is anyway out of the ordinary.

Length ...	... 33″
Span ...	... 27″
Tip to Tip ...	... 24½″
Beam ...	... at base just below first tine and coronet, 12½″. Above first tine 8″.

THAYETMYO,
BURMA,
December 23, 1930.

A. L. BROWNLOW,
D. S. P.

[The best head of the Malay Sambhar in Rowland Wards' *Records of Big Game*, (8th Edition), is in the possession of the D. H. M. Boyle. It measures L. 33″; circumference 5¾″; tip-tip 28¾″; widest inside 30″. Mr. Brownlow's specimen is remarkable for its phenomenal girth. In the Society's collection there is a single antler of an Indian Sambhar picked up in the Nimar Jungles C. P. with a girth measurement of 12½″.—EDS.]

III.—THE GAYAL, OR MITHAN (*BOS FRONTALIS*)

(*With a plate*)

Some years ago the sportsman who opened his game license in Burma found an astonishing entry—' one Mithan ' among the animals he might endeavour to shoot! Was this a facetious pleasantry on the part of the Forest Department, or was there really such a beast? Was it a Myth—or a Mithan?

There is no such intriguing entry now,* so that Myth, or Mithan, may rest undisturbed by the thought of some restless Saheb stalking them with a rifle 'suitable for the purposes'. The joke is still perpetrated though, for the mysterious Mithan is still honourably mentioned—in the list of animals protected all the year round—which but leads us back to the question *what is a Mithan*? Those who have climbed up into the mountainous country between India and Burma will have seen this queer, sacrificial animal of the Chins, Kukies, Nagas and other hill tribes, and may be able to answer the question. For those less fortunate I humbly offer some photographs of Mithan taken in the Chin Hills which may enable them to visualize this strange beast and form their own opinion as to its existence. The resemblance to the wild Gaur or Bison is at once evident, and the more we see of this curious animal the more we are inclined to accept the conclusions of the eminent ornithologist Mr. Stuart Baker, that the Mithan—or Gayal as it is called in Assam —is specifically the same as the Bison. But this does not mean that the Mithan is exactly the same animal as the Bison is, only that their affinity is such that they can freely interbreed. The wild Bison—and there is nothing to show that it has ever been domesticated—is a larger and more powerful and more active animal than its domesticated relative the Mithan, and the horns are far larger, more corrugated, longer and with a characteristic angle that at once distinguishes it from the Mithan which—in the Chin Hills at any rate—has short and straight horns which are rarely corrugated. The skulls and horns of Mithan and Bison can be distinguished at a glance from one another as the two hang row upon row in the Chin houses.

In Vol. XV, No. 2 of the *Bombay Natural History Society's Journal*, 1903, Mr. Stuart Baker has given a masterly account, profusely illustrated, of the differences and resemblances of the two animals which is of great interest. He lived for years among these beasts and killed all the record heads and besides was a highly skilled naturalist and observer. He, however, was on the Assam border where apparently crossing between the Bison and Mithan still takes place to a considerable extent, and as we should suppose, the Mithan there very closely resemble the Bison: in fact there is a more or less gradual transition between the two. This is not quite the case in the Chin Hills, however, for there the Bison have been shot out to a great extent, and the opportunity for the two to meet and interbreed very rarely occurs. Enquiries over a considerable area only brought to light a single case which occurred about ten years ago. As may be then expected the differences between the two animals are more apparent in the Chin Hills than the resemblances, whereas on the Assam border the resemblances seem paramount.

In the whole of his article, however, Mr. Stuart Baker does not touch on what is perhaps the whole crux of the matter, and that is once again—what is a Mithan?—what causes the difference between it and the wild animal? The difference can be due to either the Mithan being the survival of what was once a species of light hill Bison peculiar to these hills—or to domestic cattle crossing with the Bison. There is nothing to support the first supposition—were it so. The Chins who are hunters to a man would have some tradition of it, and extinct animals do not so easily persist in a domesticated condition. This idea, if indeed it exists, may be dismissed. Nor is there the slightest evidence that the Mithan is a pure blooded domesticated Bison. Bison are extremely difficult to keep in captivity and Mr. Stuart Baker ridicules the idea. It is then the result —this strange beast—of the wild Bison crossing the domestic cattle of the people: such indeed is their own opinion of the origin of their Mithan (I speak of the Chins). In the *Gazetteer* of the Chin Hills of 1896, it is stated that 'The Chins tell us that the *Gavæus frontalis* is not a separate animal from the *Gavæus gaurus*, and that their Mithan are the results of a cross between the wild Bison bull and the common cow'. At the fourth generation the true stage of the Mithan is reached and then it breeds true—or if allowed with the domestic cattle—until it becomes almost obliterated. In the Chin Hills every stage between the Mithan proper and the common cow can be seen—until the high dorsal crest of the Bison has been reduced to a mere hairy thickening along the back. As the herds receive more and more cow blood the horns become cow-like and all the domestic cow's varied colours begin to appear.

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* The Forest Department, in their Game Rules for the Shan States, still considers it a game animal though it has never existed in the Shan States or within hundred miles from the Shan States.

Mithan are to be found throughout this mountainous tract, from North Cachar, through Manipur to the Lushai and Chin Hills, and south to Chittagong. They are a peculiar and characteristic possession of the Hill Tribes inhabiting those regions. In the Chin Hills they are usually herded into the house compounds at night and are in many cases more gentle and tractable than the domestic cow. 'As gentle as a Mithan' say the Chins, but there are exceptions to this rule, and I have had on more than one occasion to protect my horse from being gored at night by a crusty old wanderer out for blood. At such times they roar a peculiar bellow—not unlike a mule's which is of interest as the bison is a very silent beast. I have seen an old bull charge a Chin with incredible agility and toss him five yards away into the jungle—showing a bit of his wild ancestry. Usually they are timid and harmless enough as indeed are wild Bison till molested.

I shall not forget my first sight of a Mithan. I was riding along the hill path as it wound round a steep hillside when a slight sound above me attracted my attention. I looked up and some four yards distant a magnificent bull Mithan stood gazing down at me—a Bison but for his straight horns and the proximity of a village.

Mithan are said to be hardly as numerous as they were years ago in the Chin Hills and it would be as well to discourage their too frequent slaughter in sacrifice and feast until the stock is up again. A good bull is worth about Rs. 80 now.

It is interesting to speculate on the future of this fine animal—if it is to have a future—now that the chances of getting new wild Bison blood become more and more remote as the big game becomes yearly less and less. It would be of great interest to introduce it into some other country where grazing is good, as in Australia. There it might prosper and grow to a larger size. The difficulty in most cases of acclimatization are here not present to hinder the experiment—for suitable animals can be bought in perfect condition at a reasonable price, and they are moreover docile and would not fret themselves to death during transit by sea and rail. I commend the idea for what it is worth.

If the question raised at the beginning of this article 'what is a Mithan' has not been answered, it has been raised at any rate for others to reply to, and it would be of interest to hear if they occur in other parts of the world where Bison have access to domestic cattle as they possibly have in the Malay States, Siam and Indo-China.

Haka, Chin Hills, T. R. LIVESEY.
November, 1930.

IV.—A NOTE ON THE OCCURRENCE OF THE TURKESTAN PENDULINE TIT (*REMIZ CORONATUS*) IN THE PUNJAB.

As Huhg Whistler's (*Journ. B. N. H. S.*, vol. xxiii, p. 153), appears to be the only record for the Punjab it may be worth noting that while staying at Lahore last cold weather, I came across a party of three of the above species on the outskirts of the Shahdara Rak.

They were feeding in a 'Ber' (*Z. jujuba*) tree, and I heard no note.

The party consisted of two ♂♂ and one ♀, all adult as ascertained by dissection.

The date was 1st February.

Simla, A. E. JONES.
January, 1931.

V.—NOTES ON THE WHISTLING SCHOOL BOY OR MALABAR WHISTLING THRUSH

(*MYIOPHONEUS HORSFIELDI*, Vigors).

In spite of the fact that it is a common bird throughout the hilly tracts of the Bombay Presidency, I think it is more often heard than seen ; consequently a short description would not be unpardonable. Seen from a distance it appears like a diminutive crow with a slender bill, but on closer examination, its brilliant hues become visible. It is a black bird with the greater part of the feathers of the body and tail suffused with a rich cobalt blue. Added to this, the 'forehead' and the lesser wing-coverts are a bright cobalt blue. The bill and feet are quite black, while the eye is brown.

On the whole this Whistling Thrush is a shy and retiring bird, lurking in the gloom of well-shaded rivulets, water-courses, and overhanging rocks and cliffs where there is a constant supply of water. In spite of its retiring habits the bird soon gets used to the proximity of man and will then come out of its hiding place without the slightest indication of fear. Though fond of water, it (in my experience with them) never inhabits the neighbourhood of still water, such as tanks. It is a regular bather and early in the morning may be observed engaged in having its morning bath, frequently entering the water during the hot weather. Often, it also engages in an evening splash as well. When disturbed, it flies up to the nearest rock or branch, bobs its head down, raises and spreads its tail like a fan suddenly closes it again, then erects itself and flies away giving forth a long, sharp, piercing whistle as it goes. This is the alarm whistle.

Generally single, in the breeding season they go about in pairs. They appear to preserve certain territorial rights for other birds of the same species are soon chased away if they happen to encroach on the preserve of another.

The breeding season commences with the break of the monsoon and may thus vary with the locality. Around the hills of Salsette, Khandala, and Mahableshwar, they begin to build in June, the eggs being laid soon after completion of the nest. The nests are built of moss and other vegetable fibre, sometimes lined with a few feathers, The nests are generally built in crevices and holes in overhanging inaccessible rocks.

The young are hatched in July. At first they are quite naked, but soon long black down-feathers are developed which stand erect. The skin is nearly quite black, and must protect them completely in the dark corners in which the nests are usually situated. The down feathers are highly sensitive and readily react to the slightest touch, even to that of a fine hair. I have frequently tested this point. This is what makes me inclined to believe that these long down-feathers are of a protective value to the young birds, for in the places where the nests are built, there are to be found innumerable mosquitoes and small flies which no doubt constantly harass them. That mosquitoes do worry them I have not the slightest doubt as it has been amply proved to me by the birds I have had in captivity. Between August and September the nestlings are able to fly. The down-feathers are gradually replaced by ordinary feathers to the extremity of which the down feathers remain attached for some time before they fall off. Those of the head are the last to be shed. The feathers are at first quite black but in time become suffused with the cobalt blue like the adult. The lesser wing-coverts are the first to become cobalt blue and when these have developed. the feathers of the crown follow—this is the last to be developed, Even when moulting, the blue of the feathers appear some time after the feathers have developed and not as soon as they appear.

The food of these birds consists chiefly of snails, small frogs and insects, and possibly of a little vegetable matter. Crabs are also largely eaten, so also are worms. Snails and crabs are hammered against the rocks to break the shells which are not eaten in either case.

As I have said, these birds are more often heard than seen. It is their beautiful whistle which first attracts the attention. So human and full are the notes that they have frequently deceived the listeners. There is no uniform song but one note is followed by the other much like the awkward whistling of a boy. It is in the mornings and in the evenings that these birds like to whistle best. But the monsoon is the time to hear them. It is just the time for them when there is plenty of mist and fog about and slight showers of rain.

In captivity they make most delightful pets, though they are a little dirty on account of their diet. They soon become very attached to their masters. At times they are inclined to be pugnacious, particularly towards strangers. Two can seldom be kept in the same cage as they will invariably fight. The young are somewhat difficult to rear at first owing to their delicate nature and diet. The diet in captivity should consist of hard boiled eggs and raw meat cut up into tiny pieces, to this may be added some greens and fruit. When possible, small frogs, not toads, crabs and insect-food should be given to them. A liberal supply of water should always be provided. When almost full grown, a tray with water should always be put into the cage for bathing purposes.

When taught to whistle early, these birds are excellent mimics and are able to whistle any tune. One that I had for some years, was able to whistle the song '*For me and my girl*' right through quite correctly and one or two bugle calls. There are few birds in India which are so adept in whistling.

In captivity these birds, if well looked after, will live long. I have had them for as many as seven, eight and nine years and in all cases an accident was the cause of death. One that I have at the moment, has been in captivity for the last eight years. In captivity, they moult regularly every year, just after the monsoon, usually commencing about September. It takes about two and a half to three months to complete the moult. During this period the bird is somewhat quiet. The wing feathers are the first to fall, followed by those of the tail. Then those of the body and lastly from the head. During the casting of the wing and tail-feathers many of the body feathers also fall.

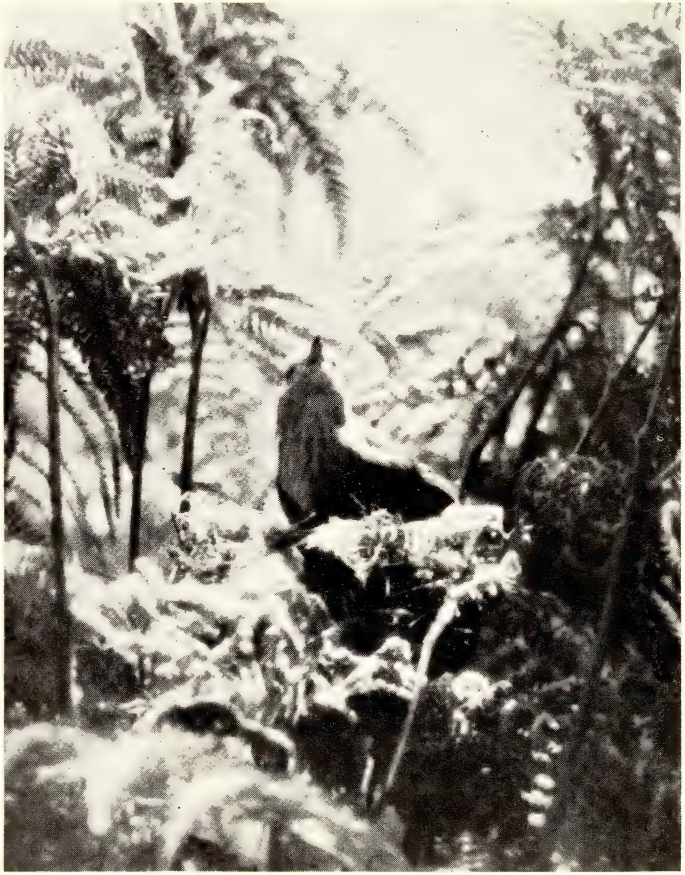
BOMBAY, C. MCCANN, F.L.S.,
November, 1930. *Assistant Curator, Bom. Nat. His. Society.*

VI.—A NOTE ON THE NIDIFICATION AND HABITS OF THE TRAVANCORE LAUGHING-THRUSH.

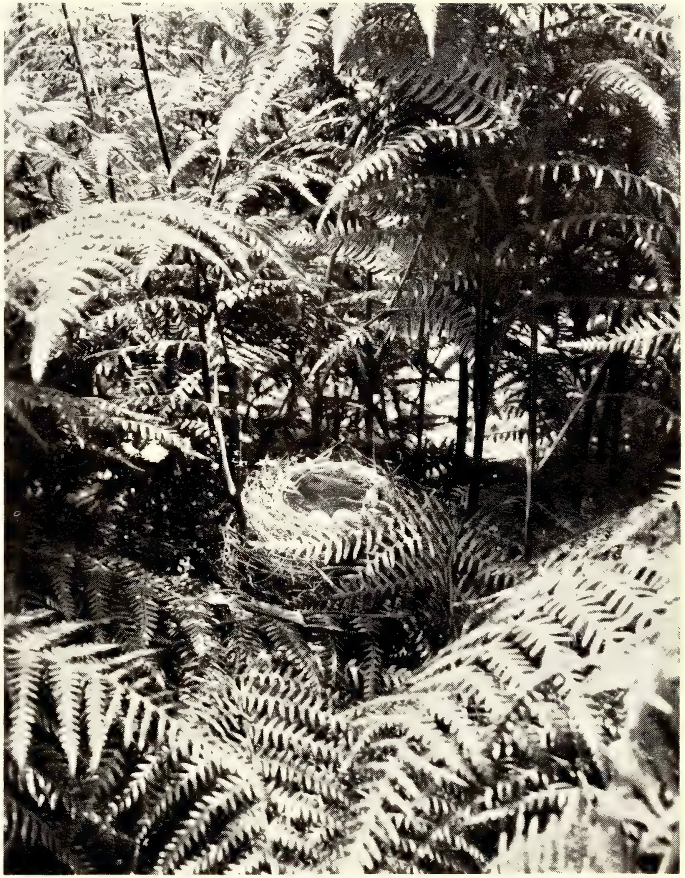
(*TROCHALOPTERUM JERDONI FAIRBANKI*).

(*With a plate*)

I have just received a copy of the lately-published *Birds of Southern India* by Lt.-Col. H. R. Baker and Mr. C. M. Inglis, from which I see that the note therein with regard to the nest of the above reads as follows. . . . 'It is, in shape, a deep cup made of moss, roots and tendrils lined with fern-stems and fine bents, etc.'



1. Travancore Laughing-Thrush at Nest.
(*Trochalopterum jerdoni fairbanki.*)



2. Nest of Travancore Laughing-Thrush.
(*Trochalopterum jerdoni fairbanki.*)

Of its habits nothing whatsoever is recorded in this volume. On turning to *The Fauna of British India—Birds*, we find no information about the nest but its habits are said to be similar to those of *cachinnans*, of which the following is written—' It is always found in parties, sometimes consisting of a dozen or more birds, and is one of the noisiest of the family. . . . It keeps much to the ground and to dense undergrowth, and though its diet is mainly insectivorous, Jerdon remarks that it feeds principally on the imported Peruvian Cherry (*Physalis peruviana*). It is said to be a shy bird except in the breeding season, when it sits very close and becomes much bolder.'

The notes on *cachinnans* in *The Birds of Southern India* read—' A very common permanent resident on the hills where it frequents undergrowth, hedges and gardens; it usually associates in small parties, the members of which keep up a continual cry of *Pee-koko, Pee-koko*, from which the bird drives its local name. It is not particularly shy, yet evinces a disinclination to come out into the open, preferring to escape notice by hopping and creeping amongst the bushes.'

From the above, we are now in a position to know something about the Travancore bird's mode of living and nest-building, but I venture to suggest that the normal nest of *Trochalopteron jerdoni fairbanki* is not as stated above, nor do the habits of *cachinnans* as given here, quite fit this bird, at any rate in so far as those observed around Kodaikanal are concerned.

I spent April and May of 1928 in the Palni Hills, and besides a number of old nests, I found the following six occupied ones :—

No. 1.	4th April.	Empty, but practically finished.
No. 2.	23rd ,,	In such a very thick hedge in the bungalow compound that I was unable to get at it, but the two young ones left the nest on this date.
No. 3.	24th ,,	Construction just begun. Contained two eggs on 7th May.
No. 4.	29th ,,	Two eggs.
No. 5.	6th May.	One egg, but two next day.
No. 6.	19th ,,	Two newly-hatched young ones.

Firstly, as regards nest materials. No. 1, I thought was not very dissimilar from many nests of *cachinnans* which I have seen, but as I discovered it torn out and lying on the ground the following day I pulled it in pieces, finding it made up as follows :—The extreme outside was chiefly of moss which formed possibly 20% of the entire structure. Coarse grass formed the remainder, while the lining appeared to be still wanting. This was the only nest in which moss had been employed to any appreciable extent, although No. 4 had a very small quantity incorporated in one side of it.

No. 3. I observed from its very inception. In fact had I not seen the birds fly into the bracken with material, I would never have realized that the half dozen untidy-looking strips of coarse grass were the foundations of a nest. This nest, which is the one containing eggs shown in the plate, was also destroyed, and but for the bracken leaves which are visible in the photograph, was exclusively of dry grass with a lining of slightly finer grass. No. 6, also built in bracken, was an exact replica of this one.

No. 5 had two small feathers and one hair mixed up with its grass lining. The remainder, including the old ones I mentioned, do not call for comment. In fact, a general description of the nest as visualized by me would run as follows:—Moss is seldom, and then only scantily, used. The structure is composed almost exclusively of coarse grass, very compactly put together, with a deep cup, lined with slightly finer grass. At times bracken leaves or other materials, depending on the site of the nest, are also used to a limited extent.

As regards habits, reading the note on *cachinnans* in *The Birds of Southern India* in conjunction with that in *The Fauna* a very fair idea of *fairbanki's* habits is obtained, but my own impressions are that it is more of a 'garden' bird than *cachinnans* and on the whole much bolder. Whereas the Nilgiri bird's stronghold seems to be the sholahs, and to a lesser extent patches of undergrowth and gardens where a sufficiency of cover exists, *fairbanki* seemed to me to shun the deeper woods, inhabiting the very edges of the sholahs, bush-dotted hillsides, and the extensive patches of bracken which clothe them, while every garden, however small, within Kodaikanal itself boasted its inhabitants. These latter birds move about the rose bushes and other plants searching for insects in quite an open manner, while the pair mentioned as having a nest in our own compound were very keen on a tall wire-netting fence. On three occasions I stood in the doorway only 8 feet distant while they fed their two young ones clambering about the top rail.

I do not agree that either of these birds keep much to the ground. They are certainly not averse to descending to it, but by far the greater part of their existence is spent in creeping about low cover or bushes at from 2 to say 6 or 8 feet up, sometimes descending to the ground as occasion arises.

The first nest mentioned, in an upright fork of a tall bush, was the only one I found in a sholah and this was in a comparatively open portion near a stream. The majority of nests were either in an upright fork in the densest part of a rather isolated bush on a bush-dotted hillside or else anchored in tall bracken which abounds all over the summits of the Palnis. These bracken nests were usually no great distance from the edge of a sholah or other cover, nest No. 6 being the most isolated, being some 40 yards from the edge of a pine-wood on the one hand, and 60 yards or so from a small stream on the other hand whose banks sported a certain amount of cover. Incidentally I never saw the birds visit the wood which after its kind had no undergrowth whatsoever.

The statement in *The Birds of Southern India* that 'It usually associates in small parties, the members of which keep up a continual cry of *Pee-koko Pee-koko* . . . . .,' is rather misleading. I have watched numbers of both races, including birds at the nest from the hiding-tent and parties feeding, and have always noticed that this cry is used by one bird to call up its mate, or companion (?), when they are separated. One of the photographs here shows a bird on the nest answering its mate which had just called out twice from where it was feeding in the bracken some 200 yards away. A couple of such calls and answers and all would be quiet again for some time until one or other of the birds, apparently becoming anxious, would raise its head high in the air, puff out its chest, and crow loudly once, twice, or thrice until it received an answer. Incidentally I never saw the Travancore bird in more than family parties, though, of course, they may become more sociable out of the breeding season.

The above impressions are the result of but a two months' acquaintance with this bird; so if some of my conclusions are incorrect, perhaps there is an ornithologically inclined member resident in Kodaikanal who will point out the discrepancies.

BAREILLY, R. S. P. BATES,
December 23, 1930. *Captain.*

VII.—THE OCCURRENCE OF THE GOLD-FRONTED FINCH (*METAPONIA PUSILLA*) AT SUKKER, SIND.

The *Fauna* gives the distribution of the Gold-fronted Finch (*Metaponia pusilla*) as follows:—Caucasus, Mountains of Central Asia, Persia, Afghanistan, Kashmir, Ladak and Tibet. It is therefore worth recording that I was lucky enough to obtain a fine specimen of this finch on January 1, 1928, at Sukkur, Sind.

I was out collecting about a mile below the Barrage, and was passing through some interesting cultivation near a village, when I flushed about five birds, which I at once recognized as something I had not seen before. They were very restless and difficult to approach. However, I managed to obtain one specimen, the others took flight, and disappeared out of sight over the top of some tall trees. I failed to find them again. The bird I obtained proved to be a juvenile male.

This finch has not been recorded from Sind before, and Dr. C. B. Ticehurst does not mention it in his list of Sind Birds.

BARRAGE TOWNSHIP, F. H. COLE.
SUKKUR, SIND,
February 10, 1931.

VIII.—THE NESTING OF THE MALABAR HEART-SPOTTED WOODPECKER (*HEMICIRCUS CANANTE CORDATUS*) IN TRAVANCORE.

I have received the following most interesting account of the nesting of this bird in Travancore, from Mr. C. Primrose. It is so widely different from the account given by Mr. Stuart Baker in *The Fauna of British India* (*Birds*) 2nd edition, that I am sending it to you for publication in the *Journal*. Mr. Primrose wrote:—

'I am sending you two eggs of *Hemicircus c. cordatus* taken on November 26, and December 15, respectively. These I have little reason to doubt, were laid by the same bird as the following details will show. The first nest, a shallow tunnel of some 5 inches in depth, made in a rotten fencing post, 3 feet from the ground, was taken by me and contained one fresh egg. Shortly after I noticed another nest being excavated on a similar post about 50 yards further along the line of fencing and, waiting till I judged the bird had time to lay, took this as well finding one fresh egg as before. The fence runs along a much-frequented path near the jungle. Both nests were not more than 3 feet from the ground and in shape the entrance was much pointed at the upper end. The bird on hearing one approach climbs up and keeps a look-out from just inside the hole, its creamy-yellow forehead and upper breast blending well with the background of the newly-worked rotten wood. It allows a close approach before leaving the nest and then only goes a short distance away and looks anxiously at the intruder, uttering its characteristic and rather metallic note and bobbing about in a jerky manner. It returns to the nest very quickly if one conceals oneself and after a look round, whilst perched at the entrance, with a final Kestrel-like bob disappears inside. I shall keep a further look-out along the many miles of fencing held up by rotting posts round this estate and see if I come across more. Incidentally the fencing posts where these nests were taken were within a few yards of heavy forest containing many dead trees and branches. The bird is certainly common here, usually seen in pairs, which attract one's attention by their noisiness'.

HULDIBARI T.E., CHAS. M. INGLIS,
BINNAGURI P.O., F.Z.S., F.E.S., M.B.O.U.
DUARS,
January 19, 1931.

IX.—THE NESTING OF THE BESRA SPARROW-HAWK (*ACCIPITER VIRGATUS AFFINIS*) AT SIMLA.

In his articles on the *Birds of Prey of the Punjab* (*J. B. N. H. S.*, vol. xxvii, pp. 139-140), Mr. C. H. Donald in his note on the above species says there are no nesting records for the province.

It is therefore worth setting down particulars of a nest which came under my observation this year on 25th and 27th May.

In the first place I ought to say that it was entirely due to the strange vociferations of the male that my attention was drawn to the fact that there was to me a strange bird-noise going on in the neighbourhood, and so sat down to investigate.

Looking in the direction from which the sound came, I saw another bird fly into the tree. From my coign of vantage I was unable to see what ensued, but I certainly think the male had called the female off the nest on account of some tit-bit he had brought.

Watching in the direction of the sounds, I had, after an interval of about six minutes, the pleasure of seeing the female fly to a nest of sticks 60 feet up a Deodar (*C. deodara*). She stood on the edge of the nest for some seconds, and then settled down on the eggs.

For forty minutes I sat watching her through the glasses, during which time she shifted round an axis of about 135 degrees. Standing up she preened herself after which she settled down again to incubation duties.

Two days later, with my climber, I again visited the spot, a quiet nullah in deep forest composed almost entirely of Deodars.

This time, as the climber ascended the tree, she sat down very low in the nest, but when he was half way up, she stood up and waited on the edge of the nest, then flew to an adjacent tree where she assumed an aggressive attitude.

The nest contained four highly incubated eggs which are white with just a tinge of green and are sparingly marked with small spots of sienna brown.

SIMLA. A. E. JONES.

X.—FURTHER RECORD OF THE MALLARD (*ANAS PLATYRYNCHA*) OCCURRING IN BURMA.

I am sending you by separate registered post the head, wings, feet and tail of a duck recently shot by me at Hnokcho, Bhamo District, on the Theingaw *jheel*. It was identified by Mr. C. E. Milner, Conservator of Forests, from Blandford's book on *Fauna of British India—Birds* as a female Mallard, but considering the very rare occurrence of this bird in Burma, I should like Mr. Milner's identification verified. If it really is a Mallard, then it is the third that has fallen to my gun within the last 4 years, the other two being recorded at page 577 of vol. xxxiv, No. 2, of your *Journal* as having been shot during the winters of 1926 and 1929.

BHAMO FOREST DIVISION,
BHAMO (UPPER BURMA),
December 5, 1930.

G. M. TURNER,
Dy. Conservator of Forests.

[The bird was received and identified by us as a Mallard (*Anas platyryncha*). This constitutes the third record of this species from Burma in recent years. EDS.]

XI.—THE OCCURRENCE OF THE SPOTBILL OR GREY DUCK (*ANAS P. PŒCILORHYNCHA*) IN UPPER CHINDWIN, BURMA.

I send herewith the upper mandible and speculum of what I take to be the Indian Spotbill, *not* the Eastern Spotbill which is the common bird in Burma *vide* Stuart Baker. Unfortunately I have not got the book on tour. So cannot see exactly what he says, but the key is if

I remember—green speculum, red spots on bill, species Indian.
—purple speculum, no red spots on bill, Burmese species.
I never remember to have shot one with any red on the base of the bill anywhere else during 20 years in Burma; but on this my first visit to the Chindwin the only two Spotbill brought to bag, on different days and on different jheels have both been like the enclosed. Dates 7th and 11th January. Locality near Homalin, Upper Chindwin.

Geese: all the geese seen on the sandbanks on the Chindwin (and we have seen 2–300) are Bar-headed (*Anser indicus*) whereas all the geese we shot on the Irrawaddy jheels near Katha, Bhamo and Mandalay, also Wellet in the Shwebo District where there are thousands—I mean thousands—are Grey Lag (*Anser anser*). Similarly at Pavyo and other jheels between Mandalay and Mingyan and Paunglin near Magwe, the geese are Grey Lag, and one only occasionally sees or gets a Bar-headed. I have two records, Paunglin Magwe—Xmas 1911, and Tiqyaung, Katha—November 1930.

Grey Lag are also seen on the Chindwin jheels but in nothing like the numbers one sees on the Irrawaddy.

White Eye (*Nyroca rufa*): Until I got the new edition of *Indian Ducks*, I have always shirked identifying Baer's, the common White-Eye and the Tufted Duck as all are in eclipse plumage here at Xmas: but the new key is more helpful and out of three pochard shot near Homalin on January 7, 1931, one was certainly a common White-eye (*Nyroca rufa*) and two Baer's White-eye (*N. rufa baeri*).

Some years ago I sent you another record from Wellet, Shwebo—Xmas 1920–1927, identified by Mr. J. C. Hopwood as Baer's.

SYLVAN LODGE,
MAYMYO,
BURMA.

E. MILNER.

[The well defined red markings of the bill and green speculum appear to indicate that the specimen secured by Mr. Milner is an example of the Spot Bill or Grey Duck (*Anas p. pœcilorhyncha*). The Burmese Grey Duck (*Anas p. haringtoni*) has no red spots on the bill or only faint traces of them. In the Eastern Grey Duck (*Anas p. zonoryncha*), the red spots on the bill are absent, and speculum is blue. This appears to be the first record of this duck in Burma. The Eastern White-Eye (*N. bæri*) is generally an unrecognized winter visitor to Burma. It is of interest therefore to publish records of its occurrence in the above note by Mr. Milner and in the succeeding note by Mr. Turner. EDS.]

XII.—OCCURRENCE OF THE TUFTED POCHARD (*NYROCA FULIGULA*) AND THE *EASTERN WHITE-EYE* (*NYROCA BAERI*) *IN BURMA*.

I am to-day sending you per registered parcel post the complete skins of two ducks shot by me on the 7th January 1931, on a small isolated *jheel* surrounded by dense cover on one of the islands in the

Irrawaddy River about 10 miles below Bhamo. I have identified them from Stuart Baker's *Indian Ducks and their Allies*, as being (1) the Crested or Tufted Pochard (*Nyroca fuligula*) and (2) the Eastern White-Eye, *Nyroca baeri*). For one identification mark that is not now visible ; I might mention that the irides of the former were a bright yellow, and of the latter white. The white spot under the chin of the latter was also much more distinct than it is now after skinning. Both birds were solitary.

I shall be glad if you will confirm the correctness of my identification of the two birds, and if you consider them of sufficient interest, record the incidents in the next issue of your *Journal*, as Stuart Baker seems to consider them somewhat rare winter visitors to Upper Burma.

BHAMO FOREST DIVISION,
January 15, 1931.

G. M. TURNER,
Deputy Conservator of Forests.

[As indicated in the previous footnote, the Eastern White-Eye is described as probably a regular though undetected winter migrant into Burma. The new Edition of the *Fauna* does not mention the Tufted Duck as occurring in Burma though Hume considered it a probable straggler. The specimens submitted to us are as identified by Mr. Turner. EDS.]

XIII.—OCCURRENCE OF THE CLUCKING OR BAIKAL TEAL (*NETTION FORMOSUM*) NEAR HARDOI, U.P.

I am sending you the head and wings of a duck which I think is a Clucking Teal, shot at Sandi Jheel, near Hardoi on January 24. It was flying in company with some Pintail only lower down when it was shot. As it is, according to the books, one of the rarer ducks, I thought it might be of interest to you. I would be very grateful if you would identify it for certain. I could not send the body as it was going bad, but in size it was about that of a very large Garganey and just too small for an ordinary duck. It was a kind of dove grey. I hope the head arrives all right.

LUCKNOW,
January 29, 1931.

H. SCOTT MACDOUGALL,
Capt., 60th Rifles.

[The duck was received by us and identified as the Clucking Teal [*Nettion formosum*]. EDS.]

XIV.—NOTES ON THE WHITE-HEADED DUCK OR STIFF-TAIL (*ERISMATURA LEUCOCEPHALA*)

While shooting an open jheel near Chillianwala, Gujrat District, Punjab, with Captain J. R. M. Hanna and Captain A. H. B. Joyce, M.C. on February 22 this year, we came upon a flock of eleven white-headed duck of which we succeeded in shooting three. An adult drake and duck, and a drake not yet in full plumage.

As I see in Stuart Baker's *Game Birds of India, Burma and Ceylon* that these are rare duck I am sending some details.

I saw these birds lying out in the middle of the jheel and with the sun behind them. I believed them, at first, to be coots, as, although we had fired all round the jheel, they had not risen.

Later I walked round to the far side of the jheel and noticed the white heads of two of the drakes and recognized them as Stiff-tail, (I had come across them previously near Nowshera in 1928).

The heads of the drakes showed up brilliantly white in the sun, while the ducks at the same distance were unrecognizable.

Of the eleven, two appeared to be drakes in full plumage, and the remainder ducks and immature drakes.

I waded in and a coolie was sent in to endeavour to turn them towards me. They all passed within 60 yards of me.

While swimming, their tails were generally lowered in the water, but when at rest on the water, the tails were erect.

The coolie drove them to one end of the jheel and on my approaching in the water they got up and flew back to the other end, a matter of eight hundred yards.

Their appearance on the wing is very coot-like, but they fly much faster. I fired at one of the mature drakes and he came down, still very much alive, and immediately dived. He remained under water for about a minute and then reappeared for a couple of seconds showing his head only. There was no reed in the water, so this duck has undoubtedly the power of swimming with only the head and neck projecting above water. He kept up these ' Submarine tactics ' for nearly ten minutes before I got near enough to kill him outright. Towards the end, when I suppose he was tired, he commenced showing more and more body above water.

The other two were killed outright from the bank.

The drake weighed 1 lb. 10 oz.; he was very fat.

There appeared to be little difference in the size of all three secured.

I examined the contents of the drake's stomach which I found to consist purely of vegetable matter.

In comparing the adult with Keulemans' illustration, I notice that in my specimen the tail is more squarely cut, each of its twelve feathers being approximately the same length and definitely black.

The eye is darker than in the illustration. There is no trace of brown in the feet, which are the same colour as, but slightly darker than the blue grey bill. The webs are black.

I have kept the drake's skin, which I should be glad to send you if it is of interest.

The Stiff-tail is poor eating. Their flesh being rank and rather coarse.

JHELUM,
PUNJAB,
February 27, 1931.

W. A. WHITEHEAD,
Capt., 1st Punjab Regt.

XV.—SOME RACES OF THE RED-BILLED CHOUGH [*PYRRHOCORAX PYRRHOCORAX* (LINN.)].

The Red-billed Choughs are distributed over a considerable portion of Europe, Africa and Asia. Curiously enough, they are grouped under the binomial *Pyrrhocorax pyrrhocorax* (Linn.), from which we assume that ornithologists are generally of opinion not to recognize any but the typical form. The approximation of body-colour of birds of the different areas naturally lends to the suspicion that there has been hardly any influence of environment at work on these Choughs, which apparently do not react to the conditions of the climate, soil and food. John Gould, however, in his examination of the Himalayan Chough detected differences in point of size, which left him in no 'hesitation to describe it as distinct' (*P. Z. S.*, 1862, p. 125) from European examples. In the dust of criticisms and controversy which subsequently raged over this point, drawing in their vortex such distinguished scientists as August Von Pelzeln, W. T. Blanford, Allen O. Hume, Ferdinand Stoliczka, etc., the true significance of Gould's observation was lost, the concensus of opinion among ornithologists deeming it absurd to found a specific distinction on the dimensions of the Chough. Recent studies, however, of the birds bring home the fact that while it is difficult, nay impossible, to ignore the above decision, it is nevertheless easy to differentiate them as geographical races or subspecies, separated from one another by immense barriers of land. The continental *Pyrrhocorax* of the Alps, if not the form found on the British Isles, is reckoned as the type, though the former is appreciably a bigger bird in respect of size. Witherby records (*A Practical Handbook of British Birds*, p. 32), measurements of British birds—♂ wing 270–310 mm.; tarsus 55–59 mm.; bill from nostril 49–58. ♀ wing 265–285 mm.; bill from nostril 42–47. Dr. Stresemann mentions (*Journal für Ornithologie*, lxxvi, 1928, p. 343), the Choughs collected by Von Gerd Heinrich in Elburs Expedition of 1927 as a distinct race (*Pyrrhocorax pyrrhocorax pontifex* subsp. nova. Typus in Zoolog. Museum, Berlin, Nr. 27. 819; Gilan: Pish Kuh 2500–3000 m. 2 Mai 1927) which, though agreeing in colouration with the European examples is decidedly larger in dimensions. Measurements recorded thereof are for 3 ♂♂ and 2 ♀♀. ♂ 318, 320, 327 mm.; ♀ 293, 305 mm. So far the difference that has been noted in respect of the birds from different areas is only one of degree, the body-colour in the European and Elburs examples being glossy black with distinct green irridescence on the wings and tail. The measurements of the Himalayan Chough recorded by Gould (*P.Z.S.*, 1862, p. 125) is—wing 324·5 mm.; tarsus 57 mm.; bill 57 mm. This is fairly corroborated by Blanford (*J. A. S. B.*, vol. xli, p. 70) who records—♂ from Sikkim, wing 324·5 mm.; tarsus 61·5 mm.; bill from gape 58 mm.; ♀ wing 292·5 to 312·5 mm. Stuart Baker's measurement noted in *The Fauna of British India*, *Birds* (2nd Edition), p. 68 is, however, clearly less and appears to tally with that of the continental if not the English birds. In Himalayan birds, Dr. Stresemann points out, the green irridescence of the wing and tail-feathers is not found and is replaced by a clearly blue gloss with a slight shade of violet

(*Journal für Ornithologie* lxxvi, 1928, p. 344). Recently, while revising the bird-collection of the Indian Museum, I have had opportunities of examining a large series of the Himalayan *Pyrrhocorax.* I notice extraordinary variations in respect of the culmen (50–103 mm.) and tarsus (50–65 mm.) both in male and female, the maximum measurement of the wing being 326 mm. The following are measurements of some specimens :—

Reg. No.	Sex	Locality	Wing	Culmen	Bill from Nostril	Tarsus	Middle toe without claw
19334	♂	Leh, Ladak.	326	56	51	58	25
19333	♂	Leh, Ladak.	322	56	49	55	25·5
16381	♂	Gilgit ...	316	50	44·5	56	24
6051		Ladak ...	316	55	48	50	25
24954	♀	Tibet ...	310	52	49	58	25
1173	♀	Sikkim ...	308	53	47	65	27
1174	♀	Sikkim ...	302	51	46	60	26
24647	♀	Bhutan ...	301	73·5	66	65	30
24198	♀		300	103	96	63	30
8286	♀	Bhutan ...	291	80	73	60	27

A living specimen (probably ♀) from the Himalayas, belonging to the Calcutta Zoo, measures as follows :— wing 300 mm. ; culmen 98 ; bill from nostril 92 ; tarsus 66 ; middle toe without claw 30 mm.

It appears from reference to above that the measurements recorded for the Himalayan Red-billed Choughs by Gould and Blanford are, by no means, the maximum, and are very often exceeded. This is fairly corroborated by Col. R. Meinertzhagen in his systematic results of birds collected at high altitudes of Ladak and Sikkim (*Ibis*, July 1927, p. 372). The following are measurements noted by him :—

Sex	Locality	Wing	Culmen	Tarsus
♂	Leh ...	340	60	56
♂	Sikkim ...	330	57	61
♂	Sikkim ...	332	60	59
♀	Sikkim ...	309	55	56

It is worthy of note that while Meinertzhagen's birds have extraordinary wing-length exceeding the maximum I have observed in the collection of the Indian Museum, the measurements of culmen and tarsus noted by me are remarkably larger than the maximum noticed by any other ornithologist. The female birds are invariably smaller in point of wing-length, though their culmen and tarsus are often disproportionately larger. The larger dimensions of these birds and the blue gloss on their primaries will, therefore, mark them out from their European cousins. The wing-length of the latter seldom exceeds 310 mm., a character which is fairly constant at least for the individuals of the British Isles. Dr. Hartert appears to consider it impossible to distinguish with any degree of satisfaction the forms in Palæarctic fauna District of W. Europe to E. Siberia. Witherby records that the European birds have greyish brown feather-bases. In my examination of the Himalayan Choughs I find that these are brownish black, lighter in tone and rather inclined to be purplish. The subspecies from Elburs mountain recognized by Dr. Stresemann as *Pyrrhocorax p. pontifex* has very much larger wing-length and is almost indistinguishable in point of size from the Himalayan examples, but the green irridescence of their plumage appears to give them a character of their own. The individuals from North China, described by Swinhoe as 'variety brachypus' (*P. Z. S.*, 1871, p. 383), are recognized by La Touche (*Handbook of Birds of Eastern China*, p. 22), as a well-established race, which resembles the Indian form in colour but is definitely smaller in size: measuring, wing 256–298 mm.; culmen 43–48; tarsus 43-49; middle toe without claw 22–30 mm.; While recognizing the small size of the Choughs of the Tian-shan, Dr. Stresemann records (*Journal für Ornithologie*, 1928, p. 344) that they are lighter in colour and inclined more to blue shades, standing halfway between the Elburs and Himalayan forms. Here for the first time an intergradation is apparent. They have, says Dr. Stresemann, decidedly sharper wings than the Himalayan birds. This variation in the shape of the primaries does not appear to have been noticed by any other ornithologist. It is a character far reaching in its importance, and we must await fuller details about the birds, which Dr. Stresemann is inclined to recognize as *Pyrrhocorax p. centralis* sub-sp. nova. There are in the collection of the Indian Museum a few skins of the Choughs of Turkestan whose measurements are noted below:—

Reg. No.	Sex	Locality	Wing	Culmen	Bill from Nostril	Tarsus	Middle toe without claw
14194	♂	Turkestan	310	52	45	55	27
13269	♂	,,	303	54	46	52	25
13283		,,	293	48	42·5	48	24
14195	♀	,,	277	46	40	53	28

These are appreciably larger than Stevens' records of Turkestan specimens published in *J.B.N.H.S.*, vol. xxix, p. 527. Here the maximum measurement hardly corresponds to the minimum of the

Himalayan subspecies. The extraordinary dimensions of the latter, which is more or less isolated in its distribution area, are not found anywhere else.

The following key may be adopted for identification of the different forms :—

Key to subspecies

A. Gloss on wings *green*
  a. Wing under 310 mm. ... British and W. Palæarctic form (*P. p. pyrrhocorax*)
  b. Wing over 310 mm. ... Elburs (*P. p. pontifex*)
B. Gloss on wings *blue*
  a. Wing under 310 mm.; culmen and tarsus smaller under 50 mm. ... N. China from (*P. p. brachypus*)
  b. Wing over 310 mm.; culmen and tarsus larger over 50 mm. ... Himalayan (*P. p. himalayanus*)

Habits and Field Characters

While in Britain, *Pyrrhocorax p. pyrrhocorax* (L.) is found in rocks and cliffs on or close to the sea-coast, nesting usually in crevices in roofs of sea-caves and hollows of rock-walls, the continental race generally affects higher mountains inland, and sometimes, though very seldom, nests in old castle, tower or human habitation. Flight buoyant, graceful. Call clear, shrill—'*Kria*, or *dla dla*' (Hartert); 'a soft *K'chufe*, and a rather querulous *tchare*' (Witherby for Br. Birds). Food varied as with *Corvidæ* generally. Nest.—Bulky. Eggs.—4 to 5 or more, 39·4 × 27·9 mm. (Witherby's average of 100 eggs); larger with continental forms (maximum 43·2 × 28 mm. recorded by Hartert); creamy white, occasionally pale green, with faint purplish grey and light and dark brown blotches.

Pyrrhocorax p. pontifex (Stresemann) nests in inaccessible mountain-tops. Young observed and heard cawing by Heinrich in the end of May. Congregations of young and old observed by him on 28th July.

Pyrrhocorax p. brachypus (Swinhoe) is a common resident in the mountains of Chihli, apparently extending its range towards E. Siberia; great flocks gather in higher hills in late summer. Eggs.—white, speckled and spotted irregularly with reddish brown over violet grey spots, the latter on the surface as well as within the shell; a zone round the large end; shape ovate; 40 × 27·5, 38 × 28 mm. (La Touche).

Pyrrhocorax p. himalayanus (Gould) occurs throughout the Alpine regions of Ladak, Kashmir, and Sikkim, in winter as low as 5,500 and as high as 16,000 ft. in summer to and even beyond 18,000 ft. (*Ibis*, 1927, p. 372). Wollaston records them on Everest (20,000 ft.) in September (*Ibis*, 1922, p. 526). In the Sikkim Himalayas it appears to be confined to the far interior, where there has evidently been no decrease in their numbers since Hooker recorded them in

1849 around *Lachen* (*J.B.N.H.S.*, vol. xxix, p. 517); rather scarce, according to Blanford, on the Cbo La Range; found in winter in the valleys and plains where they apparently migrate at the season. Equally at home on deep snow, grassy meadow, cultivated ground, or on barren plains. Numerous in Ladak from 10,000 ft. and upwards as much near villages as far away among rocky crags; mixing commonly with crows, ravens, pigeons on ploughed fields or irrigated land. While in search of food which is mostly secured on the ground, they set to work, in pairs or parties, probing their bills deep down into the earth. 'Seen about places where yaks have been herded, hunting for insects under the dung, but they also feed on berries and seeds' (Blanford). Call raucous, somewhat plaintive; 'wilder', easily arresting sportsman's attention (Adams). Flight wild, excited. Noisy, sociable and gregarious; feeding, flying and sometimes breeding in colonies or congregations. Trial of strength not unfrequent, usually between two male birds, when whichever gets the worse of the encounter has the ill luck of being molested with extra pecks of a Jungle-crow. Flocks circle at immense height, then with closed wings down come the birds, one after another in swift slanting swoop. Not wary; observed in higher altitudes to come and roost under the eaves of the houses. Nest-construction begins in March; eggs not unusual in April, and young noticed in the first week of May. The nest is built of twigs, with wool lining, and placed in clefts of rocks; but in Tibet frequently in Tibetan houses, sometimes in holes in the walls only a few feet from the ground, usually the same site being occupied year after year. Osmaston records nests built in small holes excavated in sandstone cliffs by the birds themselves, about 2 to 4 ft. deep; consisting entirely of a thick pad of hair with no substratum of sticks. Eggs usually 3 or 4 in number constituting a clutch, are 'like those of the English birds, but much duller and brownish in tint and they average much bigger, 41·7 × 28·4 mm. against 40·7 × 27·9 mm.' (Stuart Baker). The maxima, recorded by Mr. Frank Ludlow, of 17 eggs (*Ibis* 1928, p. 54) are 48·5 × 27·5 and 47·5 × 29·25 mm.

50, KAILAS BOSE STREET,
CALCUTTA,
August 28, 1930.

SATYA CHURN LAW,
M.A., Ph.D., F.Z.S., M.B.O.U.,
Honorary Correspondent of Zoological Survey of India.

XVI.—NOTES ON THE FAUNA OF BRITISH INDIA: BIRDS, CHIEFLY WITH REFERENCE TO THE CENTRAL PROVINCES.

411. **Southern Red-whiskered Bulbul. Otocompsa emeria fuscicaudata:** In the Central Provinces this bird is more addicted to forests than the vicinity of gardens and cultivation. I have only met with it in the former.

433. **The White-browed Bulbul. Pycnonotus luteolus:** Stated to be rare or absent throughout the Central Provinces. This is true to some extent but it is rather plentiful at Kamptee where it breeds freely

and whence several nests have been taken. At Nagpur it now and then visits gardens and has been observed breeding as well.

588. **The White-throated Ground Thrush. Geocichla citrina cyanotis.** This bird is resident in the C. P. and has been observed breeding in the districts of Chanda, Balaghat, Chhindwara and Bhandara.

Vol. II, page 175, line 3 from bottom :—' *Wing* 4·77 to 4·76 mm.' should probably read inches.

617. **The Purple Thrush. Cochoa purpurea.** *Habits.* Four birds whose stomachs I examined had fed largely on small land molluscs.

700. **The White-browed Fantail Flycatcher. Rhipidura aureola aureola:** *Nidification*—line 4 from bottom ' the bottom of the nest is prolonged into a cone and sometimes furnished with a long thin tail of loose scraps of grass .' This is more characteristic of the nests of *R. pectoralis* and I do not think I have ever seen it in *aureola.* Habits :—*R. aureola and R. pectoralis* feed largely on the Jassids *Idiocerus clypealis*, Leth. and *I. niveosparsus*, Leth. which adhere to the trunks of mango trees in enormous numbers, and its display with its fan-like tail seems a means for distributing these insects which are snapped up the moment they take to their wings. This genus of *flycatchers* is perhaps the most specialized of the group in this direction.

703. **The White-throated Fantail Flycatcher. Rhipidura a. albicollis.** The distribution of this species is given as ' The Himalayas from Murree to Eastern Assam, Burma, Shan States, Yunnan, Annam, Siam, Cochin China, Hainan and Malay States,' yet a little above we read ' Birds from the southern Punjab, Central Provinces and Chota Nagpur (presumably places where it is not found) are very rusty below, probably because they are all young birds.'

733. **The Scarlet Minivet. Pericrocotus speciosus speciosus.** *Distribution*: Oates in the old edition gave the distribution of this species as practically throughout the Himalayas, East Assam, U. P., Chota Nagpur and Central Provinces as far south as Bastar and Jaypur; but in the new edition its range is limited to the Himalayas, Assam, North of the Brahmaputra and eastwards to Yunnan. It is certainly found in the Central Provinces and it may be a resident. I have secured or observed it in at least four districts (Balaghat, Bastar, Betul and Chhindwara) and Osmaston has observed it in a fifth (Pachmarhi, Hoshangabad District). The latest date recorded is 21st April.

738. **The Small Minivet. Pericrocotus brevirostris brevirostris.** *Vernacular name*: *Raja Lal* is the common Hindi name for this species in Northern India.

744. **The Rosy Minivet. Pericrocotus roseus roseus.** *Distribution*: I have taken two specimens in the Central Provinces at Nagpur, one in December and the other on 2nd April.

1021. **The White-beaked Munia. Uroloncha striata striata.** Extends North in the C. P. as far as Chanda and Bhandara.

1124. **The White-capped Bunting. Emberiza stewarti.** This bird is a winter visitor or straggler to the C. P. I took a specimen on 1-12-1913 at Nagpur.

1133. **The Black-headed Bunting. Emberiza melanocephala.** This bird has also been taken at Nagpur on 20-3-1919.

1339. **The Little Scaly-bellied Green Woodpecker. Picus vittatus myrmecophaneus.** This wood-pecker is found sparingly in the Baster State and I have also taken it in the Balaghat District.

1500. **The Rosy-ringed Paroquet. Psittacula krameri manillensis:** Among the few skins of this bird in the Museum, one young male has the lower mandible entirely red as in *P. k. borealis*; an adult male has the under-surface of the lower mandible red, but it is dark at the sides. A female has it dusky but not black.

1783. **The Himalayan Grey-headed Fishing Eagle. Ichthyophaga humilis plumbeus.** This bird wanders further south than Lucknow in the winter. Specimens were taken by Mr. A. Donald at Kolkaz, Sipnachadi, in the Melghat (Amraoti District) in January 1913. One of these was presented to the Museum.

1819. **The Indian Crested Honey-Buzzard. Pernis ptilorhynchus ruficollis.** According to the key for the species of *pernis* on page 165, all birds taken at Nagpur have the black subterminal and medium bands much narrower than the paler bands and would fall under *P. apivorus.* This, however they are not for three specimens have a wing of 400 mm. one of 405 mm. and the largest 421 mm.

1847. **The Indian Green Imperial Pigeon. Muscadivora ænea sylvatica.** The Green Imperial Pigeon is found in the Central Provinces in the South Chanda district and in the Bastar State, extending North to Kanhargaon and Katori. A female from the Chanda district had a wing of 225 mm. and a male from the Bastar State had a wing of 220 mm. I think I have heard this bird further north either in the Balaghat or Bilaspur district, but am not certain.

1852. **The Emerald Dove. Chalcophaps indica indica.** Occurs in the sal forests of the Balaghat district.

1942. **The Aravalli Spur-Fowl. Galloperdix spadicea caurina.** The spur-fowls from Asirgarh in the Nimar district are much greyer than the spur-fowls of Chanda and elsewhere and appear to belong to this race or are near it.

2066. **The Yellow-legged Herring-Gull. Larus argentatus cachinnans.** I have taken this gull on the Mahanady in the Bilaspur district. *L. brunnicephalus* has also been taken at Nagpur in June.

2120. **The Eastern Golden Plover. Pluvialis dominicus fulvus.** I have taken the Eastern Golden Plover on the Mahanady at Chandrapur in the Bilaspur district. They were in a flock of about 30 birds.

2213. **The Smaller Adjutant. Leptoptilos javanicus.** The Smaller Adjutant is resident in the Central Provinces where it keeps to the well-watered and thinly populated parts. I have met it in the Nagpur, Balaghat and Bilaspur districts.

2242. **The Lesser Flamingo. Phœniconaias minor.** A specimen was shot on the Ambajheri tank at Nagpur on the 9th June 1912, it was along with a large flock of *Phœnicopterus ruber.* In the winter of the same year many of these birds were being hawked about for sale. On 29th June 1925 I also observed a flock of Lesser Flamingos flying over Nagpur.

CENTRAL MUSEUM,
NAGPUR.

E. A. D'ABREU, F. Z. S.,
Curator.

XVII.—A 'FLYING' FROG.

(*With a plate*)

The following notes relate to a specimen captured at Ernakulam, in Cochin State, on the night of the 11th June, 1930. It was found adhering to a wet towel, which was hung up in an open verandah for drying. When caught, in the words of the captor, it 'flew' towards the floor, where it was neatly bagged. It was kept in confinement for nearly three weeks, when it was killed, as it was felt that no useful purpose would be served by keeping it alive any longer. During the whole period of confinement it starved, though dragon-flies and other insects were supplied to it at different times.

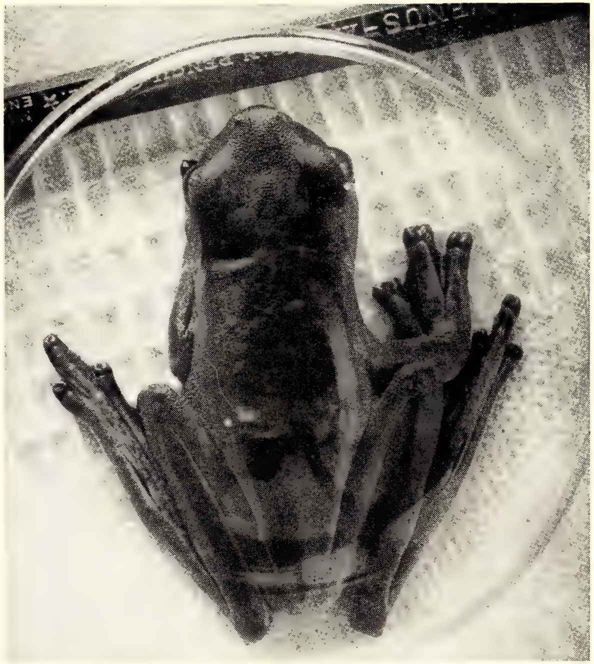
Description.—Upper surface finely granulate; under-surface of the body and snout coarsely so. The lower surface of the thigh also coarsely granulate, but, here, there are some larger granules scattered among the smaller ones.

Heel possesses a dermal appendage, which, when the limb is stretched, is nearly triangular. Snout more or less rounded, and only half as long as the diameter of the orbit. Canthus rostralis somewhat acute, with a lozenge-shaped block spot at the bottom of it. Loreal region concave. Nostril nearer the end of the snout than the eye. Inter-orbital space broader than the upper eyelid. Tympanum 5/7 or nearly 2/3 of the diameter of the eye. Vomerine teeth in two nearly transverse series, and touch the inner front edge of the choanæ. Each of the toothed ridges measures 3 mm. in length, and the two are 2 mm. opart.

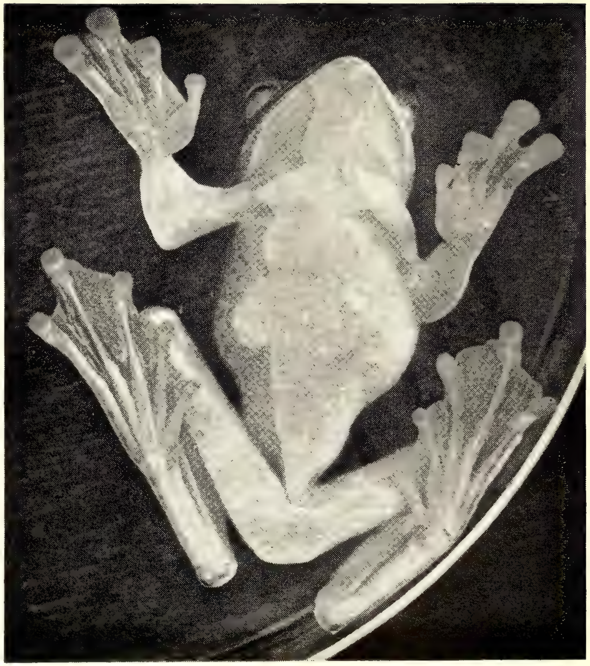
Fingers and toes webbed to the discs as in *Rh. malabaricus*, but the discs of the fingers are larger than those of the toes. Those of the 2nd to the 4th fingers about the size of the tympanum or very slightly less, that of the 1st finger only about half that size. In the foot the disc of the 3rd toe is the biggest, but even this is not as big as those of fingers 2nd-4th; next in size comes the 5th, then 3rd, 2nd, and 1st in regular order. Sub-articular tubercles well developed. In the hand the 1st digit has one inconspicuous tubercle, the 2nd one conspicuous tubercle, and the 3rd and 4th two large tubercles each. In the foot there is a tubercle internal to the hallux, at its base (probably of a pre-hallux). The 1st and 2nd toes have one tubercle each, the 3rd to the 5th two tubercles each.

The tibio tarsal articulation reaches the nostril as in *Rh. malabaricus*, and as in that species that is a dermal fold of a white colour (colour not mentioned Boulenger's description of *Rh. malabaricus*) along the outer margin of the forearm and tarsus. The fold along the forearm is continued on to the hand to the tip of the outermost digit, just as the tarsal fold is continued on to the foot to the tip of the outermost toe. The latter fold becomes continuous anteriorly with the dermal appendage of the heel. There is, moreover, in my specimen, a similar white fold across the buttock just above the vent. When the frog is in an absolutely resting posture the folds of the two legs become continuous by means of this supra-anal fold.

A "FLYING" FROG.



1. *Rhacophorus malabaricus*, Jerd. (Dorsal view*.)



2. *Rhacophorus malabaricus*, Jerd. (Ventral view.)

* *The dark bands on the back were not present in the actual specimen. They were caused by the refraction of the glass dish which was used to cover the animal when photographing.*

Colour.—In the living animal the back is of rich leaf-green colour, to harmonize with the foliage in the midst of which it lives in Nature. Sides of the body with a yellowish background speckled with circular green spots of size. Ventral surface light yellow. Sides of the thigh of a deeper yellow. Digits and discs yellow. Outer margins of the outer digits of both the limbs green like the back, so that when the limbs are folded in the resting posture, nothing but green is seen. Even in captivity when leaves were put inside the glass case in which it was imprisoned, it required a very careful examination to detect the animal. The upper-arm nearly yellowish with only a green streak above. In the position of rest this section of the limb is hardly visible. The dermal fold, as already noted, is of a chalky white colour. Upper edge of the post-axial side of the thigh marbled red. Eyes, of a speckled golden hue with a horizontal slit-like pupil, which when the frog is 'sleepy' extends almost from end to end.

In the (forefoot) the ground colour of the web is yellow. Between the three outer digits the yellow is rayed with red. Between the 1st and 2nd digits it is purely yellow, without any red streak at all. In the hind-foot the web when expanded is pinkish, rayed with yellow or light streaks; when folded, the colour becomes deeper, almost red. There is a double ray of greyish blue in the webbing between the two outermost digits.

Measurements—(taken immediately after death).

From snout to vent	$2\frac{1}{2}$ inches.
Hand expanded	1·25 sq. cm.
Foot expanded	4·1 sq. cm.
Diameter of orbit	7 mm.
Length of snout	4 mm.
Interorbital space	8 mm.
Breadth of upper eyelid	5 mm.
Diameter of tympanum	5 mm.

Habits.—The man who caught the specimen and brought it to me stated with great wonder that it 'flew' slantingly to the ground. There is no reason to disbelieve his statement, as 'flight' could not have been associated in his mind with an animal like a frog, and there was not the remotest possibility of his having heard of a 'flying frog' before. It must have been a piece of correct observation. Mr. M. O. Parthasarathy Iyengar, who describes a specimen from near Sagar in the Mysore Province (*Records of the Indian Museum*, 1915—,vol. xi, 140–142) which he calls *Rh. malabaricus* says he saw it actually flying a distance, roughly, of 30–40 yards. His account is, however, very meagre, and I cannot say with any degree of certainty whether the two specimens belong to the same species. I am in the unfortunate position of A. R. Wallace who described a 'flying frog' for the first time from Borneo. He himself never saw it flying, but was assured by the Chinese workman who brought it to him that he saw it doing so. I have tried various manœuvres to see my specimen flying, in enclosed rooms, but had to content myself with the spectacle of various kinds of acrobatic feats, except flying.

I dared not take it out into the open, as I found that it was an expert jumper, and feared that in the open it would make good its escape by a few leaps, which would take it out of my reach, and probably out of my sight also, particularly in view of its wonderful protective colouration. It jumps apparently without any effort, and on one occasion, at any rate, its jump was suggestive of flight. When jumping it has the webs fully extended. It was never tired of jumping at any time of its captivity, and in spite of its continued starvation, it would indulge in its gambols if encouraged to do so. If it misses its aim it lands dexterously and is never hurt. It can jump repeatedly from heights which are fatal to ordinary frogs. It is an active and skilful climber as well, climbing up vertical heights with ease and grace. When jumping, with the webs extended and the variegated colours shown to the best advantage, it was a most picturesque object to look at. It naturally, like all cold-blooded animals, likes a little moist surroundings, but does not tolerate water. I put it into the ' frog tank ' in my laboratory several times, when it invariably jumped onto the side wall, above the water level. If repeatedly put in water against its will, it gets tired, and then practically floats on water with its limbs and webs stretched out. It is by no means afraid of man, but allows itself to be petted, and sometimes even clings to him in preference to the branches of trees put in its case to give it as nearly as possible its natural surroundings. In captivity it was ordinarily rather sleepy, but I had only to moisten it with a little water, and it at once would wake up, bulge out its eyes dilate its pupils which then became more or less elliptical, and was then intent on mischief. It would take aim at the spectator or keeper and jump on to his face or glasses, if he should wear any, spitefully, it would seem. Its attention could be called by making a tap at the door or window when it jumps towards it. It was one of the most lovely creatures I set my eyes on, which I was indeed loathe to kill. But it consistently refused to take any food, and by the 5th of July when it was killed it had become rather famished and the bulging of the sides of the abdomen had disappeared.

Nevertheless it was even then capable of taking long leaps as before.

There is, I am told by an old gentleman who happened to see it, a popular belief with as much truth about it as in beliefs of that kind, that if by any accident this creature should jump on to the bodies of babies, the waist of the latter would get constricted like its own. The significant point about this legend is that it implies that these frogs have been seen before by common people, though not possibly recorded. I showed the photographs to certain country gentlemen some of whom at once attested to the marvellous leaping power of the animal.

Systematic position.—The first time a 'flying frog' was recorded and described was from Borneo by A. R. Wallace to whom it was brought by a Chinese workman. *Rh. pardalis*, as he calls it, differs from my specimen in several important particulars. Wallace says (*Malay Archipelago*, p. 29) ' the webs were black, rayed with yellow.' The colour of the web of the present specimen is quite different.

Wallace does not mention the mottling of the sides, and from the illustration of the animal given by him in the next page, the sides seem to be of a uniform—probably whitish—colour. The measurements of Wallace have been seriously questioned by Gadow *Cambridge Natural History*, vol. vii, pp. 246–47) who thinks that Wallace was guilty of a little confusion, which accounts for the exaggerated figures. But the measurements of my specimen, except as regards the total length do not agree with those given even by Gadow. Apart from the distribution which is against the specific identity of the two, there are enough differences pointing to the conclusion that the present specimen is not referable to Wallace's *Rh. pardalis.*

Mr. M. O. Parthasarathy Iyengar has described a 'flying frog' from Sagar in the Western Ghats region of the Mysore Province, which is probably referable to the same species as mine. The description is however meagre, and touches upon only a few points of systematic interest. In general, however, the colour scheme agrees with that of the present specimen although there are differences, e.g., the underside of his specimen is 'bright yellow' while it is only 'pale yellow' in the one under notice. The sides are speckled according to his description with dark brown spots, while in my specimen the spots are green. The measurements of the expanded hand and foot also fairly agree in the two specimens. He identifies his specimen as *Rh. malabaricus.* I have gone through the description of *Rh. malabaricus* given by Boulenger in *The Fauna of British India*, (Reptilia and Batrachia) with which, it must be admitted, my specimen agrees most closely of all species of *Rhacophorus* described therein. I am not satisfied that my specimen belongs to the same species. I give below side by side, in two separate columns the important points of resemblance and difference between *Rh. malabaricus* as described by Boulenger, and my specimen :—

Resemblances

1. Fingers webbed to the discs.
2. Vomerine teeth in two straight series touching the inner front edge of the choanæ.
3. Loreal region concave.
4. Nostril nearer the end of snout than eye.
5. Inter-orbital space broader than upper eyelid.
6. Tympanum 517 or 213 diameter of eye.
7. Sub-articular tubercles well developed.
8. Tibio-tarsal articulation reaches the nostril.
9. Skin finely granular above, more coarsely beneath ;

Differences

1. Snout rounded and not sub-acuminate.
2. Snout only half as long and not as long as the diameter of the orbit.
3. Canthus rostralis acute and not obtuse. Moreover there is a black lozenge-shaped spot at bottom.
4. While the discs of the fingers are about the size of the tympanum as in *Rh. malabaricus* those of the toes are much smaller.
5. (i) The colour scheme entirely different with the exception of the green above. The

Resemblances—continued.

granules under the thigh intermixed with larger ones.

10. Outer border of forearm and tarsus with a dermal fold.
11. Heel with triangular dermal processes.
12. Green above.
13. Distribution—Malabar.

Differences—continued.

yellow of the under surface may fade in spirit into white, but even in spirit the bright colour of the web especially of the foot is not lost, although it diffuses into a uniform light pink.

This, if present, in *Rh. malabaricus* could not have failed to be noticed.

ii. The white of the dermal fold also is not mentioned.

iii. ' The one or two black spots on either side, behind the arm ' are not seen in my specimen.

6. The dermal fold above the vent, mentioned for *Rh. maximus* but not for *Rh. malabaricus.*
7. Length only 2½ inches and not 4". But this may not be a real difference. It may only mean that my specimen is young.

To my mind, at any rate, the differences are sufficiently numerous and important to entitle my specimen to a distinct specific rank. I shall not however be dogmatic on this point until I have an opportunity of examining a type specimen of *Rh. malabaricus.*

References

1. A. R. Wallace ... *The Malay Archipelago.*
2. Gadow ... *Cambridge Natural History,* vol. vii Amphibia and Repiles.
3. G. A. Boulenger ... *Fauna of British India,* vol. on 'Reptilia and Batrachia'.
4. M. O. Parthasarathy Iyengar. A South Indian Flying Frog—*Rhacophorus malabaricus.* —*Records of the Indian Museum,* vol. xi, 1915, pp. 140–42.

MAHARAJA'S COLLEGE,
ERNAKULAM,
October 3, 1930.

K. KARUNAKARAN NAYAR,
Professor of Zoology.

[Professor Nayar's note amplifies the description given by Boulenger in the volume on Reptilia (*Fauna of British India*) particularly in reference to colouration. The specimen referred to was submitted to Dr. Malcolm Smith at the British Museum, who identified it as *Rhacophorus malabaricus* he writes : ' some of the differences quoted by Prof. Nair are not apparent to me and others can be accounted for by individual variation. The only marked difference is the shape of the snout, but it rather looks as if your specimen had banged its nose at some time and spoilt its shape. The difference between the size of the digital discs of the fingers and toe is correct as stated by Prof. Nayar and Boulenger has evidently overlooked this point '. As regards the question of injury to the snout, Prof. Nair has since obtained a second specimen in which the snout is exactly as in the first, i.e., rounded and not subacuminate and from which he concludes that the difference in shape indicated by him could not have been due to an accident as suggested by Dr. Malcolm Smith. The second specimen has also been examined by Dr. Malcolm Smith. He writes : ' The snout is certainly flatter than in specimens here, but the tip of the snout in *Rhacophorus* is subject to the same variation as in *Ixalus* and depends, I believe, upon how much of it is absorbed during metamorphosis.

That the Green Tree Frog (*R. malabaricus*) and *R. nigropalmatus* the ' Flying Frog ' of Borneo alluded to by Wallace can ' fly ' or rather plane, is a well established fact now and probably the same power is given to all the species of *Rhacophorus* with broadly webbed digits. If another specimen can be collected we would suggest that one be allowed to jump from a considerable height—the top of a tree out in the open, if several people are below to catch it again it can hardly escape. EDS.]

XVIII.—ENCOUNTER WITH A HAMADRYAD (*NAIA BUNGARUS*).

On October 1, 1930, I accompanied my clerk to inspect teak tree stumps in Compt. 77, Sinthe Reserve, Yamethin District, Burma. About 8 o'clock in the morning I arrived at a stump which was situated 20 ft. high on the side of a ravine. The top branches of a teak tree had fallen into the ravine and were resting about 3 ft. above the actual bed which was covered with firm but damp sand. Opposite me as I was standing on the top branches was a still smaller ravine, running at almost right angles to the one I was standing in. This smaller ravine went up at a steep angle and had a bed, also, of firm damp sand.

As I found everything in order, I told my clerk to go and hammer up the stump, which was about 40 ft. away from and above me, with my hammer. While this was being done I saw a large snake—about six inches in girth—come down the bed of the little ravine opposite me. At first it did not see me but when it did so, it stopped immediately about 4 yards from me. For about 5 minutes it watched me intently although I had made no movement. At last tiring of this I told my clerk, who was waiting at the stump for me to move, that there was a large snake in the small ravine and that he was to throw a piece of rock at it. However, as he could not see the snake he threw the piece of rock to me which I picked up. All the time the snake watched me very intently but made no movement whatsoever, its head being an inch off the ground. I, then, threw the piece of rock which, if the snake had not recoiled, would have hit it fair and square. The snake next rose up—its head being some 2 ft. from the ground and its neck distended to about 4 inches in breadth. With a loud hiss, it rapidly advanced towards me. Fortunately, I had with me a thick cane tipped with steel and, as it came at me with extraordinary rapidity, I aimed a blow at its head but missed and caught it a hard blow on the body some 3 ft. behind the head. This caused it to writhe in agony and allowed me to continue to shower blows on it. The snake recoiled and I found time to notice that I had lost six inches off my stick. Then I heard a loud hiss and the snake again came for me. I showered blows on it until my stick broke in 3 pieces leaving about 14 inches in my hand. As I had no stick I turned and ran up the bank. The snake also turned and followed me for about 10 yards. Fortunately I had so injured it that it could only travel slowly and I was able to pick up a bamboo and kill it outright.

The snake measured 8 ft. 5 inches in length and was marked by bands at every 2 inches. Its general colour was olive green—the bands being a little lighter than the rest of the body. They were by no means distinctive. Very unfortunately I was uninterested at the time and kept no records of it. The Burmans called it 'Nan-thandwin' or, according to the Burmese Dictionary a 'belted' hamadryad.

PYINMANA,
BURMA,
November, 1930.

P. A. W. HOWE.

XIX.—WEIGHING FISH WITH TWO OR MORE SCALES.

In reply to Capt. Macgregor's interesting account in Vol. XXXIV, No. 3 of the 15th November, I produce for him, and any others, who may care to benefit from it, Thomas's method of weighing fish under similar circumstances from his *Rod in India,* page 38, para. 4.

'When I bought my fishing tackle I thought a spring-balance weighing up to thirty-two pounds was big enough for any man. But one fine day I had the misfortune to catch a Mahseer well over that weight and, of course, I was particularly anxious to know its exact weight. I had in camp two spring-balances, weighing respectively up to twenty-eight pounds and thirty-two pounds. I passed a stout cord through the rings of the two, and suspended them from a bough; then a cord attached to the fish and passed over the two hooks, suspended the fish simultaneously from them both. Reading of the weight indicated by the two instruments and adding them together, the result was the weight of the fish, forty-six pounds. If neither of the springs, is pulled down beyond its power of springing, the total is bound to be accurate. I have tested it.'

Capt. Macgregor's was an unusual fish, if a Mahseer, though I must admit that before I had finished reading his graphic account, I was convinced it was a *Goonch* (*Bagarus garrelli*) he had hooked.

It certainly had in its fight all the characteristics of a *Goonch* ; and if a Mahseer, I can only surmise, must have been schooled by one.

It is an accepted theory that fish attain weight not by age only, but by the size of the stream and environments. The Namhpok Kha may be a small stream and his fish a very old one which would partly account for the sulking and the long drawn-out fight. The teeth or scales, would show this. Capt. Macgregor's theory, couched in humour, of the fish I mentioned, I accept as it is meant, and agree it must have been about 14 lbs.'

There is certainly ample scope for writing a most interesting book on fishing in Burma, but this lot must fall to some member of the Burma Military Police, or the Burma Frontier Service in both of which there are more competent pens than mine and some excellent fishermen with good opportunities. I myself am no longer a resident of Burma, and so out of touch, or I should have gladly tackled the task.

URNA ESTATE, MARHOWRAH P.O., A. MACDONALD.
SARAN DIST., BEHAR & ORISSA,
December 30, 1930.

XX.—CANNIBALISM AMONG FISHES.

In a small glass aquarium in my laboratory in which a few fishes were kept, mainly for show, there were two specimens of *Anabas scandens*, three of *Macrones vittatus* and one each, of *Ophiocephalus striatus* and *Saccobranchus fossilis*. They were apparently getting on for some time like 'a happy family', and I never imagined that I was, like the Round Table Conference, confronted with a vexed *minorities* problem. But a tragedy happened two days ago which has very much shaken my equanimity. The only specimen of *Saccobranchus fossilis*, about 6 ins. long, was found last Monday morning when I came to the Laboratory, not only dead, but completely stripped of its flesh, as if orders had been issued to the rest of its *confrères* to make a neat skeletal preparation of it. There were marks of injury on one specimen of *Macrones*, in which one of the eyes had been nearly gouged out, on *Ophiocephalus* which had lost a few of its head scales, and on one specimen of *Anabas*, which showed a whitish streak on one side of the base of its dorsal fin. Evidently there was a fight, and *Saccobranchus* did not allow itself to be murdered without a struggle. The act was, no doubt, cowardly on the part of its enemies, but to apportion the blame in just measure to the denizens of the tank is a rather difficult task. *Ophiocephalus* is, I fancy, the chief aggressor. Only about a month ago a small specimen of the same species kept in the tank—which is well protected—mysteriously disappeared, and I had even then my own suspicion whether his bigger brother was not responsible for his disappearance. This creature, which, in the presence of man, is extremely shy, never takes any food when others are fed. Generally they are given minced frog's meat once a week, when he keeps himself perfectly aloof and has none of it. Pressed by hunger, and probably also prompted by his innate cannibalistic instincts, he must have swallowed his little brother a month ago, and encouraged by the gastronomic effects of that meal he probably attacked *Saccobranchus*, who being in a minority, not only did not receive any help from the rest of the inmates, but was actually harassed by them. *Saccobranchus*, faced with heavy odds, used its formidable spines right and left, and created a certain amount of respect for it, before it was overpowered and killed. And then the cowardly assassins could not apparently think of celebrating their ignominious triumph in a more fitting way than by feasting on the flesh of their erstwhile comrade, and now the lifeless victim of their heinous crime.

MAHARAJA'S COLLEGE, K. KARUNAKARAN NAYAR,
ERNAKULAM, *Professor of Zoology.*
January 28, 1931.

XXI.—EXTENSION OF THE RANGE OF *HIDARI BHAWANI, ELYMNIAS PEALII*, AND *BHIMA UNDULOSA.*

The following notes on the capture of two species of butterflies and one species of moth may perhaps be of interest as considerably extending the hitherto-known ranges of these insects.

(1) **Hidari bhawani**, DeN. (*Hesperidæ*). One male taken near the town of Toungoo on the Sittang River, Lower Burma, on the 24th August, 1928. I did not see any others. Brigadier-General Evans in his *Identification of Indian Butterflies* gives the Arakan coast as the locality for this species, so this record extends its range a considerable distance eastwards.

(2) **Elymnias pealii**, W. M. (*Satyridæ*). One male taken on the 23rd November, 1929 in a glade in evergreen forest near Kokaung Forest Rest House, which lies about 4 miles west of Namma, a town on the railway about 40 miles S. W. of Myitkyina, Upper Burma. As far as I know, this is the first record of this butterfly from Burma proper, as Brigadier-General Evans only gives it as very rare in Assam and General Tytler records only a few specimens from Manipur and the Naga Hills.

Both the above were kindly identified for me by Captain Riley of the Natural History Museum, South Kensington.

(3) **Bhima undolosa**, Walk. (*Lasiocampidæ*). Two males taken on the 10th November, 1929 in the Kaing Reserve of the Pyinmana Forest Division, Upper Burma. While clearing the boundaries of a teak plantation, I found, on a large *Yon* tree (*Anogeissus acuminata*, Wall.), a grey felted patch of cocoons. This patch was oval in shape and about 3 feet long by 18 inches wide. Some 20 recently emerged

imagines, all males, were still at rest on the patch and I took 8 of these, but later threw away all but two as they had become very greasy. I am told by Mr. Tams of the Natural History Museum, that this is the first record of this moth from Burma and that it may possibly turn out to be a new subspecies. I wish now that I had not been so hasty in discarding most of those I took, but I did not then take much interest in moths and only kept the two specimens as I was rather attracted by their curious shape. I might add for the benefit of others who may have the fortune to find the larvæ or cocoons of this moth, that they are better not touched with the bare hand, as a plainful rash is the result.

c/o A. SCOTT & CO.,
RANGOON,
December 3, 1930.

D. G. CRAWFORD,
Indian Forest Service.

XXII.—CURIOUS BEHAVIOUR OF BUTTERFLIES IN THE INTERIOR OF EXTREMELY DENSE EVERGREEN FOREST.

I do not know whether it would interest your readers to know that butterflies in the interior of an almost impenetrable evergreen forest up here, do not seem to fear man. I was working with a gang of coolies cutting a way into the interior. The butterflies there would come and sit on the coolies and on me. They sat on my hat, my arm, my hand, my putties, and on my boots, sometimes half a dozen at a time. The one sitting on my hand sucked my perspiration with its proboscis and then inspite of my jerking it off from my hand, it would come and sit again on it. This went on for about five minutes when I proceeded onwards to my work. Next day I pointed my finger at a butterfly. It came and sat on it and began to suck my perspiration. Some of these butterflies I saw in Dehra Dun and had to work hard to catch one of them with a net.

CAMP MAKUM JN. P.O.,
UPPER ASSAM.

K. MOHAN LAL, I.F.S.,
Assistant Conservator of Forests,
Dibrugarh Dn.

XXIII.—NOTES ON THE COFFEE LOCUST (*AULARCHES MILIARIS*, LINN.)

This locust is quite common on the island of Salsette, but is more in evidence during the monsoon months when it has reached maturity, as in the dry months it is totally absent till about the end of February. In March I have come across large parties of small 'hoppers' feeding on the leaves of *Heterophragma Roxburghii*, DC. The 'hoppers' though brightly coloured, were sitting with impunity on the upper surface of the leaves. These were no longer than $\frac{3}{4}$ of an inch. When alarmed, they all dropped to the ground and disappeared in the dry leaves. At this stage, as in the adult, they are gregarious. It would be interesting to know whether these parties are always composed of individuals from the same brood or a combination of others.

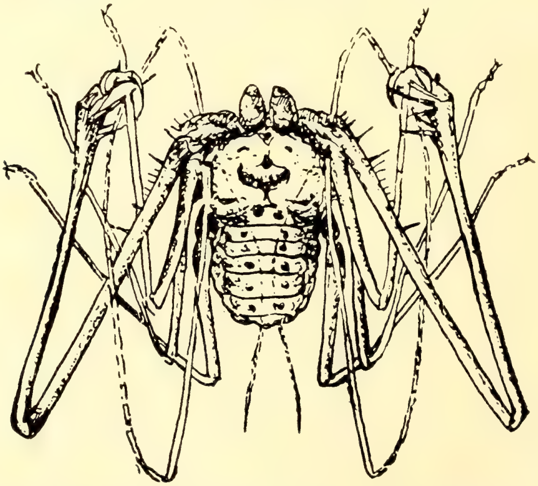
In July the adults are very plentiful. They go about in parties from thirty to fifty (perhaps more) and like the young, sit in the open on the top of foliage. At this period I have observed them feeding on the leaves of *Gloriosa superba*, Linn. In one particular locality I found that all the specimens of this plant in the neighbourhood of such a party were completely eaten barring the stems. When approached and they apprehend danger, they either drop to the ground or fly very lazily to a neighbouring bush. The flight is very heavy and laboured, and usually not prolonged. When caught, they exude a frothy substance from a pore at the base of the jumping legs which soon permeates the surrounding atmosphere. The secretion has a very pungent odour, and in the case of those that I found feeding on *Gloriosa*, it smelt like the crushed leaves of that plant.

It is possibly due to their warning colours and their means of defence, by way of this obnoxious secretion, that these insects are never taken by birds, and it is this that makes them sit in the open with impunity, while other members of their family look for shelter. I do not mean by this that these insects are conscious of their protective colouration, but that habit coupled with the advantage of protective colouring, has made them bolder than their brethren. Such protection is of use to the insect against would-be enemies and not its natural enemies which keep it in check.

Bombay Natural History Society, Bombay,
December 15, 1930.

CHARLES McCANN, F.L.S.

XXIV.—OCCURRENCE OF *PHRYNICHUS PHIPSONI*, POCOCK, IN SALSETTE ISLAND.



Reproduced from the Fauna Brit. Ind., Arachnidæ.

On the 10th of June 1930, I came across a solitary specimen in one of the water cisterns of the Kanari Caves. The cistern was partially dry at the time, there being a little water here and there after the recent showers of rain. The insect was lurking in a dark corner under the stones. It always adhered to the undersurface of the stones (i.e. with its back to the ground). When first discovered, it was in this position. I touched it to make it move in order to follow its actions. It made off with a sideways movement like a crab and got under another stone. It is also capable of moving forward and backward with considerable speed, but the crab-like movement appears to be the usual method of progression. The two long flagella are kept in constant motion, swinging slowly in all directions, each flagellum keeping in touch with everything in its half circle.

The action of the flagella and the locality inhabited by this curious creature makes me inclined to believe that it adopts ' fishing habits ' in obtaining its food. It is possible that with the rise in the level of the water the insect keeps just above the water level with its flat body adpressed to the rocky walls of the cistern, which it resembles, and from this position plays with its flagella on the surface of the water thus attracting ' fish ' in the way of aquatic insects and tadpoles (the cisterns abound with tadpoles during the rains) which are speedily taken up out of the water by the chela which are extremely long and seem well adapted to this method of obtaining prey. It must be understood, that I only put this forward as a plausible explanation of the way in which this insect obtains its food and that my theory is not based on actual observation. It is only how matters presented themselves to me at the moment as to the possible use of such long tactile feelers and the extremely long chela.

BOMBAY NATURAL HISTORY SOCIETY, BOMBAY,
January 20, 1931.

C. McCANN, F.L.S.

PROCEEDINGS

ANNUAL REPORT OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR ENDING DECEMBER 31, 1930

Administration :

President.—H. E. The Right Hon'ble Sir Frederick Sykes, P.C., G.C.I.E., G.B.E., K.C.B., C.M.G.

Vice-Presidents.—H. H. The Maharao of Cutch, G.C.S.I., G.C.I.E. ; Rev. E. Blatter, S.J., Ph.D., F.L.S. ; The Hon'ble Sir Ernest Hotson, K.C.S.I., O.B.E., I.C.S.

Executive Committee, Bombay.—Mr. R. D. Bell, C.I.E., I.C.S.; Mr. H. A. W. Brent ; Rev. Father J. F. Caius, S.J. ; Mr. Alwyn Ezra, F.R.G.S., F.Z.S. ; Mr. J. B. Greaves ; Prof. V. N. Hate, B.Sc. ; Mr. J. G. Ridland ; Major S. S. Sokhey, I.M.S. ; Mr. A. Forrington (*Honorary Treasurer*) ; Sir Reginald Spence, Kt., M.L.C., F.Z.S., Mr. P. M. D. Sanderson, F.Z.S. (*Joint Honorary Secretaries*).

Advisory Committee.—Mr. T. Bainbrigge Fletcher, F.E.S., Pusa ; Mr. T. R. Bell, C.I.E., Karwar ; Brigadier W. H. Evans, C.I.E., R.E., Quetta ; Lt.-Col. F. C. Fraser, I.M.S., Coimbatore ; Dr. F. H. Gravely, D.Sc., Madras ; Mr. C. M. Inglis, M.B.O.U., F.Z.S., Darjeeling ; Mr. R. C. Morris, F.R.G.S., F.Z.S., Coimbatore ; Major E. G. Phythian Adams, F.Z.S., Nilgiris ; Dr. Baini Prasad, D.Sc., Calcutta ; Lt.-Col. R. B. Seymour Sewell, M.A., Sc. D., I.M.S., Calcutta ; Mr. H. C. Smith, I.F.S., Maymyo ; Lt.-Col. C. H. Stockley, O.B.E., D.S.O., M.C., Meerut.

Staff.—S. H. Prater, M.L.C., C.M.Z.S., Curator ; C. McCann, F.L.S., V. S. LaPersonne, M.B.O.U., Asst. Curators.

HONORARY SECRETARY'S REPORT.

The Society's Journal.

The Thirty-fourth Volume of the Society's Journal was commenced during the year. Among the more important scientific contributions were :—

Mr. Pocock's paper on the 'Panthers and Ounces of Asia' in which the sub-species and local races of Asiatic Panthers are dealt with on the lines followed in his previous paper on Tigers. Four new races are recognized and described. The Indian Panther (*Panthera pardus fusca*), according to the author, is very imperfectly known. He believes that there are probably several distinguishable races now grouped under the name of *fusca*, which strictly belongs to a Bengalese type. Series of skins and skulls of Panthers from various parts of India are required for study before any definite conclusions can be arrived at. Members of the Society could help in the solution of the problem by presenting material either to the Society or to the British Museum.

Mr. Pocock in a second paper deals with the 'Lions of Asia'. The author endeavours to settle, as far as the literature and material before him permit, the character and status of the Lions of the Asiatic Continent.

In a paper on the 'Abnormal Tusks of Elephants,' Sir Frank Collyer, of the Royal College of Surgeons, London, discusses the probable causes of the production of multiple tusks in elephants and describes a few specimens which shed light on their etiology. Our thanks are due to Mr. C. R. Pawsey, I.C.S., Deputy Commissioner, Naga Hills, Assam, Mr. R. C. Morris, Mysore, and the Burma Forest School, Pyinmana, for their kindness in supplying examples of pathological ivory for the purpose of this study.

Papers on birds include Mr. P. F. Wickham's 'Birds of the Upper Burma Hills' which was concluded during the current year. The author indicates that a great deal of ornithological work remains to be done in these hills and that the status of various races of birds occurring in these ranges is but imperfectly known. The paper supplements the information on the birds of the area now available in the new edition of *The Fauna* and corrects certain inaccuracies as regards distribution. The last number of the *Journal* published during the year contained Part I of a paper by Mr. J. K. Standford, M.C., I.C.S., and Dr. C. B. Ticehurst, M.D., M.A., on 'The Birds of the Prome District, Burma', to which further reference is made under 'Expeditions'. A preliminary report on the results of the Vernay Scientific Survey of the Eastern Ghats relative to the birds obtained by the Survey in the Salem District was published under the joint authorship of Messrs. N. B. Kinnear and H. Whistler. The report is the first of a series of papers which are to be published embodying the Scientific Results of the Survey. In his notes on a 'Tour in Further Kashmir', Mr. B. B. Osmaston comments on various species of birds observed during an expedition into the Highlands of Kashmir. In his account of the Ornithological Station at Heligoland, Mr. Salim Ali describes the methods employed in investigating and recording the migration of birds and indicates the need in India for a central organization for ornithological research.

A paper on the 'Monitor Lizards of Burma' by H. C. Smith, gives descriptions and notes on the 5 species of Monitors which occur in Burma. Dr. Baini Prashad gives a list of the Fishes of the Manchar Lake and the surrounding area. Papers of economic interest to Indian fisheries are 'Methods of Fishing in the Punjab,' by M. Hamid Khan and Mr. F. Mitchell's article on the 'Introduction of Trout into Kashmir'.

During the year under review Lt.-Col. F. C. Fraser published Part XXXV of his serial on 'Indian Dragonflies' which contains a description of a new species. A second new species is described by the same author in a separate paper. In his Report on a 'Collection of Ants in the Indian Museum, Calcutta,' Mr. Durgadass Mukerjee includes descriptions of 6 new species. Papers of economic value have been submitted by the Department of Entomology, Indian Lac Research Institute. Messrs. P. S. Negi, M. P. Misra and S. N. Gupta, members of the staff of the Institute, in an article on 'Ants and the Lac Insect' list 8 more species as associated with the lac insect than have hitherto been recorded. The authors are of opinion that ants in general are not injurious to the lac insect and that many of them, especially the Large Black Ant (*Campomotus compressus*) are helpful. The same authors contributed a paper on the 'Noctuid Moth' (*Eublema amabilis*) which does more injury to lac than any other single predator or parasite of the lac insect. The paper gives a detailed description of the larval, pupal and imago stages of the moth and an account of its life history and concludes with physical and chemical measures to be adopted in its control. In his paper on the 'Aphidæ of Mysore,' Mr. B. Krishnamurthi makes a further contribution to the knowledge of the Aphidæ of Mysore, records notes on common forms and includes descriptions of 6 new species by F. V. Theobald of the Agricultural College, Wye, Kent. Mr. C. E. Fellows-Manson supplements Preston Clark's 'Description of two new species of Sphingidæ of the Oriental Region' with notes on the distribution, etc., of these species.

Botanical papers include the Rev. Fr. Blatter's 'Revision of the Flora of the Bombay Presidency' of which Parts XI, XII and XIII were published during the period under review. In his series of articles on the 'Flowering of Bamboos', which were concluded, Fr. Blatter discusses problems connected with the periodic flowering of these plants. His paper forms a comprehensive review of what has been ascertained so far on this complex subject. Other botanical contributions include 'Notes on the flowering and vegetative growth of Aroids,' by C. McCann, and a paper on the 'Fresh Water Algæ of Manipur, Assam,'' by K. P. Biswas.

We were fortunate in being able to publish during the year Major G. Covell's paper on the 'Malaria Problem in Bombay,' based on the results of his recent survey. The paper supplements and brings up-to-date the previous investigations of Liston and Bentley into a problem which seriously affects the health of this city.

In a separate class is Mr. Waite's interesting paper on the 'Origin of Continents and Oceans' which has been described as a most lucid exposition of Wegener's celebrated theory of the evolution of the present configuration of land

and sea on this planet—a theory of remarkable interest to Biologists and Palæontologists, offering as it does, an explanation of the reason for the widely different character of the fauna of areas now separated by narrow insignificant straits—a condition particularly evident in the differing faunal regions of South-East Asia and Australia. The importance of environment and isolation in directing evolution along a more or less definite line is being increasingly appreciated. We were glad therefore to be able to publish Dr. Hora's interesting address before the Section of Zoology at the Seventeenth Indian Science Congress on the subject of the 'Value of Field Observation in the Study of Organic Evolution'. Dr. Hora bases his paper on his study of the modifications undergone by the Fauna of torrential streams. The author, while not under-rating other avenues of investigation, professes his belief that the most effective method of interpreting the why and the wherefore of organic evolution is by direct observation of the organism in its environment. The Zoological Survey of India, of which the author is a member, has always considered Field Research as an important part of the duties of the staff. That the policy of extensive field-work has been effectively pursued in recent years is indicated in the series of articles we published during the year on the History and Progress of the Zoological Survey of India. Besides indicating the manifold activities of the Survey, our object in publishing these articles has been to stimulate the interest of our members in the premier Zoological Research Centre in the East and to show how the work of this Institution can be helped by the efforts of laymen.

While scientific contributions form an essential and important feature of the journal, the Editors have endeavoured to identify the publication with one of the main objects of the Society, namely the popularizing of Natural History in all its branches. Popular articles, attractively illustrated in colour and in black and white, have continued to form a distinctive feature of the *Journal*. The issuing of 3 coloured illustrations with each number is no small item of expenditure but the *Journal* is the principal advantage of Membership and the Committee is doing all that it can to increase its value and attractiveness to Members. We are confident that in return members will help by making the *Journal* better known among their friends and thereby increase our membership. The serial on 'Beautiful Indian Trees' of which Parts III, IV and V were published during the year is an especially welcome feature. It is the first attempt to issue a really well-illustrated series of articles on the more conspicuous Flowering Trees of India and the thanks of the Society are due to authors, the Rev. Fr. Blatter and Mr. W. S. Millard. We hope eventually to issue the serial in book-form.

Mr. Stuart Baker continued his interesting serial on 'Indian Wading Birds'. His articles have been a feature of our *Journal* for many years and the Society is deeply indebted to him for his unfailing help in adding to the interest and attractiveness of its pages. His untiring labours and his manifold contributions to Indian Ornithology, deserve the thanks and appreciation of all Ornithologists and laymen. Mr. H. Whistler's serial on the 'Study of Indian Birds' was continued during the year. It is intended as a guide to all those who wish to take up this fascinating study. The author's skilful treatment of his subject amply fulfils the purpose for which he writes. We must also mention Major Hingston's very readable and charming studies of Indian Insect Life. His constant contributions to the pages of the journal are much appreciated.

Big-Game hunting in India finds its place in this year's publications in Lt.-Col. A. H. E. Mosse's instructive articles on 'The Panther as I have known him.' and Mr. Morden's 'Notes on an Expedition after *Ovis poli*.' The author's experience indicates that, provided one has the means and one is able to obtain a permit to enter the country, a hunting trip after *Ovis poli* in the Russian Pamir presents no unusual difficulties and can be a very enjoyable experience. Other popular papers include Major W. B. Trevenen's 'Fishing in the Rivers of the C. P.', in which the author introduces the novice to the attractions, the waters of the Central Provinces hold for the fisherman.

We have again to thank a large number of members who contributed to the Miscellaneous Notes published at the end of each number. They form a very readable feature of the *Journal* and offer an opportunity to every member to contribute to the interest and usefulness of its pages.

PUBLICATIONS.

During the year under review, the following new publications were issued :—

Game Birds of India.—By Stuart Baker, Volume III. **Pheasants and Bustard-Quail.**—The present volume forms a complement to the two volumes in the series previously published by the Society and has long been awaited by members. The next volume will deal with the Partridges and Quails, but publication must be postponed till at least a good proportion of the money invested in the present volume has been recovered.

Bird Charts.—As indicated in the previous report, the Society was able to issue during the year under review sets of charts illustrating 210 Indian Birds in colour. The charts are intended primarily for the use of Schools and Educational Institutions. They supply a long-felt want, providing as they do illustrations in colour of a large series of **Common Birds of the Indian Plains.** We can reasonably hope that they will achieve the purpose of familiarizing the children in our Schools with the birds of the country. Although designed for Schools, the Charts would be an acquisition in Messes and Clubs in the mofussil.

Forthcoming Publications.—The Committee sanctioned the publication by the Society of Capt. Bates' Book on '**Bird Life in India**'. The author is well known to the readers of the *Journal*. His well written and beautifully illustrated articles on Indian Bird Life have formed an attractive feature of its pages. Capt. Bates has been remarkably successful with his camera-portraits of Indian Birds and his book is profusely illustrated with examples of his fine work. Its low cost should ensure a ready sale. The price to members is Rs. 6–12.

EXPEDITIONS AND EXPLORATIONS.

The Vernay Scientific Expedition to the Eastern Ghats was completed during the year. A preliminary account of this important survey, which the Society owes to the generosity of Mr. A. S. Vernay, was given in our previous report. Mr. LaPersonne who was in charge of the Survey made collections of Birds in the Salem, Trichinopoly, Cuddapah, Kurnool, Godavari and Vizagapatam Districts. The total number of specimens collected number 1,777. The material is being worked out by Mr. N. B. Kinnear and Mr. H. Whistler and a Preliminary Report on the collection was published by them in the *Journal*. The authors record their appreciation of the work done by Mr. LaPersonne and indicate that the Survey has been a great success and that very substantial results are expected from it, as the material now available provides important data in regard to the distribution and status of various species and races of Indian Birds. 1,621 Mammals were collected in the same area by Mr. N. A. Baptista. The material collected by him is of great value as it has been obtained from areas which were not touched by the Mammal Survey.

Survey of the Arrakhan Hills.—In January 1930, Mr. Henricks, an assistant in the Bird Department, was sent to assist Mr. A. R. Villar, Conservator of Forests, Prome District, in a Bird Survey of the Arrakhan Hills. Henricks toured the area between January and April. A collection of 353 birds was obtained. The collection is now being worked out by Dr. C. Ticehurst and a report will be duly published.

Naga Hills.—In January 1930, an expedition was sent on behalf of the American Museum of Natural History, New York, with the object of collecting material for a group of Gibbons, and incidentally obtaining material for a similar group for our own Museum. Special facilities were given to the expedition by the Government of Assam and our party received great assistance from Mr. C. R. Pawsey, Deputy Commissioner of Mokokchung, Naga Hills. The members of the expedition included Mr. C. McCann, Assistant Curator, Mr. K. B. Sawardekar, artist, and Mr. Gilbert Nogueira, modeller. Eighteen skins of Gibbons in all stages of colouration were obtained for the Museum, as well as a fine series of skins of the Capped Langur, (*Semnopithecus pileatus*) and the rare Stump-tailed Monkey (*M. arctoides*). In addition, a number of small mammals and birds were collected. The latter including a good set of skins of the Peacock-Pheasant (*Polyplectron chinquis*). Paintings of the type of country inhabited by Gibbons were made by Mr. Sawardekar and specimens illustrative of the plant-life were collected. The material will be used for a habitat group of Gibbons which it is hoped shortly to erect.

BIRD MIGRATION IN INDIA.

3,000 rings were issued during the year in connection with the Bird Banding Scheme of the Society. Eight recoveries were reported and recorded in the *Journal*. This makes the total number of recoveries thirty-two.

INVESTIGATION INTO TOXICITY OF VENOM OF INDIAN SCORPIONS.

In connection with the above investigation, we must record our appreciation of the help received during the year from Museums, Government Hospitals and Dispensaries which continued to send numbers of live scorpions from all parts of India. This has enabled Fr. Caius, who has been conducting the investigation, to add considerably to the material available for his present research—Reports of the amount of venom obtained from various species during the present year were published in the *Journal*.

THE PRINCE OF WALES' MUSEUM.

The Trustees of the Museum, in adopting the report of the Sub-Committee which recommended the building of a new wing for the Natural History Section of the Museum, have set aside the sum of two lakhs of rupees towards the cost of the new building. The sum apportioned does not permit the commencement yet of the work of erecting a building which is estimated to cost 5½ lakhs, setting aside the not inconsiderable sum that would be required for its equipment. The fate of the scheme now depends on the support it receives from the general public. Trade depression and the distractions attendant on an acute political upheaval have considerably limited the chances of success of an appeal for money from the public at the present time. It is however gratifying to record that a donation of Rs. 10,000 towards the building fund has been received by the Society from H. H. The Maharaja of Cutch and a donation of Rs. 5,000 from H. H. The Maharaja of Bhavnagar. Our thanks are due to Their Highnesses for this generous support.

Pending the decision of the Trustees in regard to the erection of a new building for the Natural History Section, few additions were made to the existing galleries during the year under report. Work was concentrated mainly on exploration, research and the cataloguing of collections.

A list of the contributions to the Museum from 1st January to 30th September 1930 has already been published in the *Journal* and a supplementary list completing the contributions for the year will shortly be published.

Thanks to the generosity of Mr. F. V. Evans, a Vice-Patron of the Society, the work of preparing wax models of Marine Fishes from local waters was continued duirng the year. Mr. Evans in addition to paying for the services of the Modeller, also made a donation towards the cost of the show-cases for exhibiting the fine series of models of fishes presented by him. Another benefaction of Mr. Evans is the many valuable books he presented to our library during the year. The thanks of the Society are due to Mr. Evans for the assistance and continuous support he has given so generously to the Museum.

We would also express our grateful appreciation of the help we have received from Mr. A. S. Vernay, Mr. A. R. Villar and Mr. J. K. Stanford who organized important expeditions during the year; to Lt.-Col. R. W. Burton, Lt.-Col. C. H. Stockley and Capt. L. D. W. Hearsey for their fine contributions to the collections; to Mr. Stuart Baker, Mr. H. Whistler, Dr. C. B. Ticehurst, Brigadier W. H. Evans, Rev. Fr. Blatter and the Staff of the British and Indian Museums for their willing help in the identification of specimens submitted to them, and in conclusion we would pay our tribute of thanks to Mr. W. S. Millard for the continuous and valuable work he has done for the Society ever since his retirement to England. He has never failed to respond to the numerous demands we make consistently on his time and attention.

STAFF.

The Committee take this opportunity of placing on record their appreciation of the work done by the Curator, Mr. S. H. Prater, C. M. Z. S., M.L.C., and his staff both scientific and clerical.

REGINALD SPENCE,
P. McD. SANDERSON,
Joint Honorary Secretaries.

March 16, 1931.

THE HONORARY TREASURER'S REPORT.

Revenue Account :

Dealing first of all with the Revenue Account : The figures on the expenses side of this account remain very similar to those which appeared in the 1929 account.

This year's Entrance Fees amount to Rs. 1,620 against Rs. 1,814 in 1929, and subscriptions this year show a reduction of Rs. 1,970 when compared with last year's figure.

The Taxidermy Department shows only a small profit of Rs. 3–13–3 this year as against Rs. 192–14–9 last year. In regard to this I would point out that another man was engaged in this department from April 1930 which has caused the profit to be lower.

It will be seen that the Revenue Account shows a loss of Rs. 667–3–4 as against a loss of Rs. 2,995–14–7 last year.

Publication Account :

After paying the author his profit on the 'Snake Books', the publication account shows that a profit of Rs. 588-5-4 has been made this year on the Society's publications. Last year this figure was only Rs. 115.

Balance Sheet :

The Balance Sheet discloses quite a satisfactory position again this year.

Assets :

The Assets side of the Balance Sheet is self-explanatory except that a note is due in regard to the heading 'Game Books'—a number of these have been sold during the year and there is as a consequence a balance of Rs. 2,356-6-2 to be transferred to the Surplus Assets Account.

Liabilities :

Turning now to the liability side, the Life Membership fees amount to Rs. 46,100 this year as against Rs. 42,600 last year.

Under our Articles we have to maintain Government paper investments up to the total value of our Life Membership fees. It will be seen from the Balance Sheet that our investments amount to Rs. 70,487-8-0 and we have, therefore, complied fully with the requirements of our Articles.

The amount of Rs. 19,448 8-7 shown under the heading 'Donations for Specific Objects Unexpended' is held by the Society as a Trustee.

Surplus Assets :

We have to add to last year's balance the profit on 'Game Book' sales and we have also to deduct the sum of Rs. 2,813-5-1 being the necessary depreciation on our securities and also a small loss on the Revenue Account.

The securities have in no case been written up and the depreciation is merely a routine one to bring our 3½ % Government paper to market value on the 31st December 1930. The net difference, therefore, of the Society's position between last year and this year is a profit of: Rs. 131-6-5.

Last year the loss amounted to Rs. 4,403-7-5.

Membership :

During 1930 we enrolled 81 new members, three old members rejoined us, while 112 resigned. The new members enrolled in 1930 show a decrease of 9 over new members admitted in the year 1929.

Resignations in 1930 were, as already stated, 112 against 125 in 1929. Our total membership on 31st December 1930 was :—

Life Members	...	205
Ordinary Members	...	1,113
Total	...	1,318

A. FORRINGTON,
Honorary Treasurer.

March 14, 1931.

BOMBAY NATURAL HISTORY SOCIETY

BALANCE SHEET AS AT DECEMBER 31, 1930

LIABILITIES	RS A P	RS A P	RS A P
Life Membership Fees			46,100 0 0
Donations for specific objects unexpended:			
Show Cases, etc.		3,803 8 7	
Building Fund		15,645 0 0	19,448 8 7
Sundry Creditors:			
Printers of Journals		3,145 12 3	
,, Game Books, Vol. III ...		2,904 10 0	
Audit Fee		250 0 0	
Author's Profits		200 0 0	6,500 6 3
Surplus Assets—			
As per last Balance Sheet		32,629 14 9	
Add: Balance brought forward from 'Publication' Account		588 5 4	
,, Game Books Sales, Vols. I and II ...		2,356 6 2	
		35,574 10 3	
Deduct—			
Investments Depreciation ...	2,146 1 9		
Loss on Revenue Account ...	667 3 4	2,813 5 1	32,761 5 2
Total ...			1,04,810 4 0

ASSETS	RS A P	RS A P
Investments at par or market value whichever is lower—		
Rs. 28,000 Govt. 3½% Pro. Notes at 63 $\frac{5}{16}$%	17,727 8 0	
,, 10,000 ,, 4% 1916/17 Loan at 90%	9,000 0 0	
,, 15,000 ,, 5% 1945/55 ,, at par.	15,000 0 0	
,, 8,000 Bom. Dev. 6½% loan 1935 at par.	8,000 0 0	
,, 14,000 Port Trust 4% Bonds at 72¾%.	10,185 0 0	
,, 15,000 Imp. ,, 4% ,, at 70½%.	10,575 0 0	70,487 8 0
Investments for Specific Purposes—		
Rs. 10,000 Govt. 6% 1933-36 at par ...	10,000 0 0	
,, 500 ,, 5% 1944-55 ,, ...	500 0 0	
On Fixed Deposit with Banks	5,125 0 0	15,625 0 0
Cash—		
With National Bank of India Ltd., Bombay in Current Account	1,355 11 2	
With National Bank of India Ltd., London, £38-11-0 at 1/6	514 0 0	
With National Bank of India Ltd., Bombay, on Fixed Deposit	2,900 0 0	
On hand	150 0 0	4,019 11 2
Sundry Debtors		1,691 4 0
Furniture: As per last Balance Sheet ...	2,165 0 0	
Less Depreciation	200 0 0	1,965 0 0
Publications, excluding Journals, at cost ... *Note.*—Any publications which have been on hand over 2 years have been written off.	...	600 0 0
Game Books, Vol. III...	...	3,299 15 11
Bird Charts	...	7,121 12 11
Game Books, Vols. I & II—at cost	65,520 10 8	
Less realized to date	57,868 14 2	
	7,651 12 6	
Already written off in previous years ...	10,008 2 8	
Transferred to Surplus Assets Account. *Note.*—50% of any book profits to be paid to Authors. A stock of 17,550 old Journals and the valuable Research Collection and Library of 2,400 volumes have not been taken into account on the asset side of the Balance Sheet.	2,356 6 2	
Total ...		1,04,810 4 0

We have prepared the above Balance Sheet from the cash book and from information given to us, and have verified the investments and deposits.

In our opinion such Balance Sheet represents a true and correct view of the state of the Society's affairs according to the best of our information and the explanations given to us.

BOMBAY, *March 11, 1931.*

(Sd.) A. F. FERGUSON & CO.,
Chartered Accountants, Auditors.

(Sd.) A. FORRINGTON,
Honorary Treasurer.

REVENUE ACCOUNT FOR THE YEAR ENDED DECEMBER 31, 1930

	RS A P	RS A P		RS A P	RS A P
To Salaries	19,958 14 0		By Salaries recovered	4,691 15 0	
,, Income Tax	552 12 0		,, Entrance Fees	1,620 0 0	
,, Society's Contribution to Provident Fund	1,556 11 0		,, Subscriptions	26,781 13 3	
,, General charges	1,054 15 9		,, Taxidermy	4,066 3 0	
,, Rent	2,436 0 0		,, Interest	4,331 0 9	
,, Printing and Stationery	603 6 6		,, Himalaya Expedition	1,295 4 0	
,, Postage	1,549 13 0		,, Sales of Journals	4,796 10 11	
,, Furniture depreciation	200 0 0		,, Advertisements	270 0 0	
,, Fire Insurance	100 0 0				47,851 14 11
,, Audit Fee	250 0 0		,, Loss		667 3 4
,, Taxidermy	4,061 5 9				
,, Library	632 14 9				
,, Cost of Journals	15,562 5 6	48,519 2 3			
Total ...	...	48,519 2 3	Total ...	...	48,519 2 3

PUBLICATION ACCOUNT FOR THE YEAR ENDED DECEMBER 31, 1930

	RS A P	RS A P		RS A P	RS A P
To Author's Profit on Snake Books ...		200 0 0	By Sales—		
,, Reimbursement of previous year's expenditure		588 5 4	Snake Charts	284 0 0	
			Poisonous Snake Books	214 10 8	
			Society's and other Publications	289 10 8	
Total ...	...	788 5 4			788 5 4

Birds Charts Account

	RS A P	RS A P		RS A P	RS A P
,, Messrs. Vitty & Seaborne Ltd., and other charges on account 'Bird Charts'. ...		12,832 12 11	By Sales—		
			Plates to Madras Government	4,125 0 0	
			Bird Charts	1,586 0 0	
					5,711 0 0
			,, Stock ... —	...	7,121 12 11
Total ...		12,832 12 11			12,832 12 11

Game Books, Vol. III

	RS A P	RS A P		RS A P	RS A P
,, Messrs. John Bale Sons & Danielsson Ltd. Game Books, Vol. III	4,687 6 5		By Sales—		
,, Balance due to Messrs. J. B. Sons & Danielsson Ltd., £217-17 at 1-6 ...	2,904 10 0		Game Books, Vol. III	4,292 0 6	
		7,592 0 5	Stock	3,299 15 11	
Total ...	...		Total ...		7,592 0 5

BOMBAY NATURAL HISTORY SOCIETY

ACCOUNT FOR THE YEAR ENDED DECEMBER 31, 1930, FOR INCOME AND EXPENDITURE OF DONATIONS FOR 'SPECIFIC PURPOSES'.

	RS	A	P	RS	A	P		RS	A	P	RS	A	P
To Expenditure on Survey of Shell Fishery.	869	6	0				By Unexpended balance for Show Cases as per last Account	7,649	5	5			
,, Expenditure on Show Cases, Modeller's salary, etc.	6,744	4	6	7,613	10	6	,, ,, for Museum Building	5,000	0	0			
,, Balance carried to Balance Sheet ...	...			19,448	8	7	,, Donations for Show Cases, etc. ...	3,767	13	8			
							,, ,, Building Fund	10,520	0	0			
							Interest received on Building Fund Donation	125	0	0	27,062	3	1
Total ...	...			27,062	3	1	Total ...	...			27,062	3	1

BOMBAY, *March 11, 1931.*
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Chartered Accountants, Auditors

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EDITED BY

P. M. D. SANDERSON, F.Z.S., S. H. PRATER, C.M.Z.S., M.L.C.,
AND C. McCANN, F.L.S.

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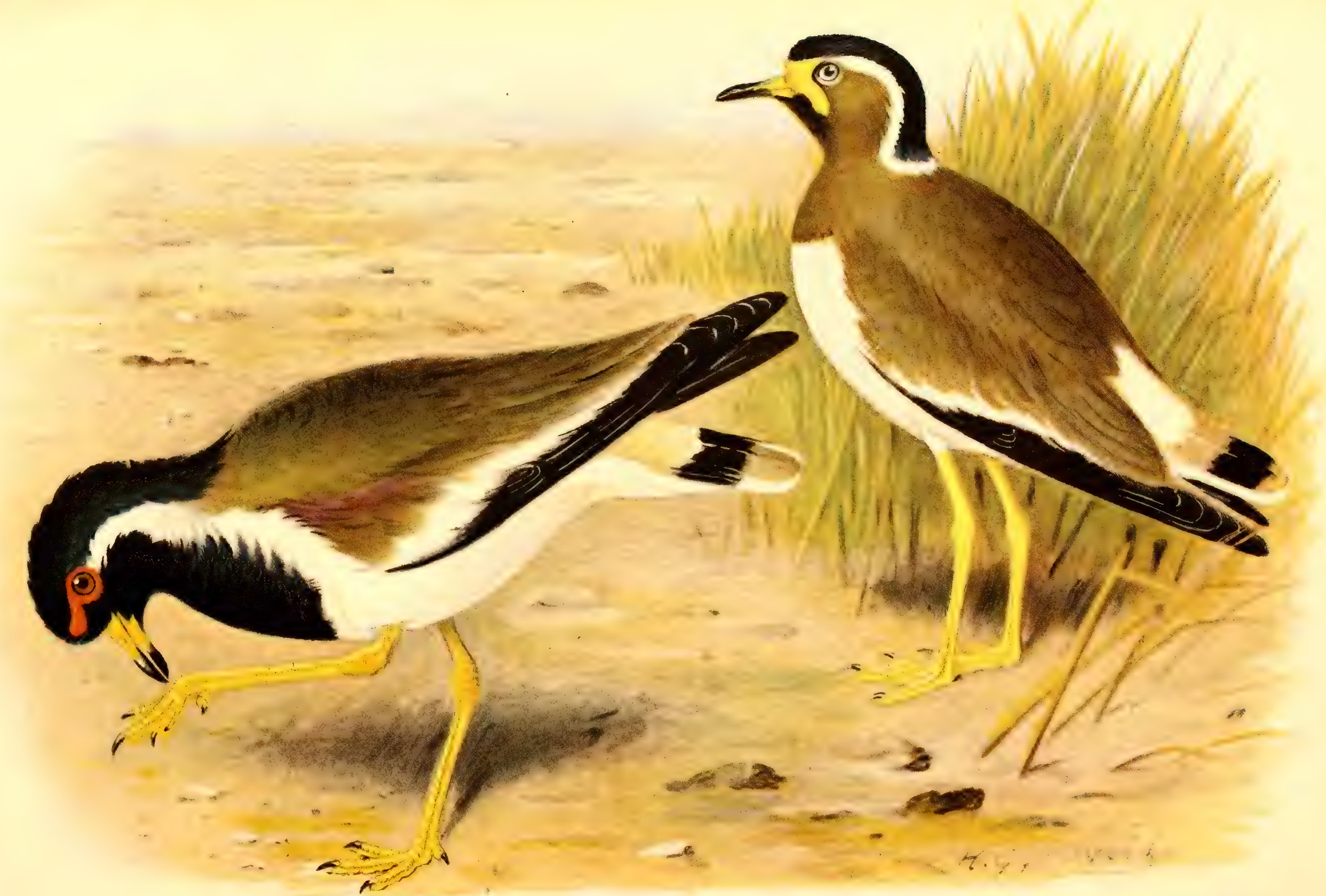


John Bale, Sons & Danielsson, L^td London.

The Indian Red-wattled Lapwing. 2/5.
Lobivanellus indicus indicus.

The Yellow-wattled Lapwing. 2/5.
Lobipluvia malabarica.

JOURNAL
OF THE
Bombay Natural History Society.

OCTOBER, 1931. VOL. XXXV. NO. 2.

THE GAME BIRDS OF THE INDIAN EMPIRE.

BY

E. C. STUART BAKER, F.Z.S., F.L.S., M.B.O.U., H.F.A.O.U.

VOL. V.

THE WADERS AND OTHER SEMI-SPORTING BIRDS.

PART XV.

(*With a colour plate*).

Genus: HOPLOPTERUS.

Hoplopterus Bonaparte, Georn. Arcad. Rome, xlix, p. 55 (1831).
Type by mon., *Charadrius spinosus* Linn.

This genus is distinguished by possessing a long, curved spur on the bend of the wing; the wing is rounded, the second primary longest; the tarsus is long, slender and reticulated throughout; there is no hind toe.

HOPLOPTERUS DUVAUCELII.

The Spur-winged Plover.

Charadrius duvaucelii Lesson., Dict. Sci. Nat., Vol. xlii, p. 38, 1826 (named from the same specimen as Wagler) Calcutta.

Charadrius ventralis. Wagler., Syst. Av., n. ii (1827) (Calcutta).

Hoplopterus ventralis. Blanf. and Oates, iv, p. 229.

Vernacular Names.—None recorded.

Description.—Whole crown and full crest to the nape, lores, chin, throat and cheeks black bordered with white; hind neck vinous-grey, passing into light brown on the back, rump, scapulars, inner coverts and inner secondaries; upper tail-coverts white; tail white at the base, black on the terminal half, the outer tail-feathers

NOV 27 1931

narrowly tipped with white; primary coverts and primaries black, the bases of the latter white, this increasing in extent until the central secondaries are pure white; outer lesser wing-coverts black; median and greater coverts white; upper breast almost white, shading into vinous-grey on the sides of the neck and browner-grey on the lower breast; centre of abdomen black; remainder of underparts white.

Colours of soft parts.—Iris dark brown; bill black; legs and feet horny-brown to reddish-black.

Measurements.—Wing 185 to 205 mm.; tail 88 to 94 mm.; tarsus about 64 to 67 mm.; culmen 26 to 28 mm.

Distribution.—Practically the whole of Eastern India as far west as, and including, the Central and United Provinces; Assam, Burma, the Indo-Chinese countries and South China. In the north-west it extends to the foot-hills of Garhwal and Kashmir.

Nidification.—The Spur-winged Plover breeds over the greater part of India during March and April but I have taken eggs in the end of February, whilst Osmaston has taken them on the Narbudda River in early May. These eggs, of course, are all laid so that they may be hatched and the young removed before the floods drown them out but, occasionally, they seem to have a second nest in late September or October when they make use of the higher islands and sandbanks above ordinary floods. Unlike most plovers these birds never breed in colonies; sometimes on large sandbanks or beds of shingle two or three pairs may be found together, though even then the nests are separated as widely as possible. The bird breeds both on the rivers in the plains of India and on small swamps at a considerable elevation in the foot-hills of Garhwal, Kashmir and the Eastern Himalayas. The site selected may be any small island or spit running into the river but the birds undoubtedly prefer shingle to sand and will often deposit their eggs in scrapings made in amongst quite large boulders. Occasionally also they may be found breeding in open marshy lands amongst terns and other birds and I once took a clutch of four eggs in a mustard field, in which the crop stood nearly a couple of feet high. The normal clutch of eggs is four, as with other plovers, but in some of their breeding areas three eggs only seem quite common. They are very like the eggs of the Red-wattled Lapwing but on the whole they are duller and more grey or olive brown in general tone, as well as being rather more long in shape. The ground colour may be any tint of stone-yellow, dull grey-brown or buff, very seldom at all warm or bright. The markings consist of numerous blotches, spots and smudges of blackish with other secondary similar shaped markings of pale lavender and grey. The markings of all kinds are distributed numerously over the whole surface of the egg and it is very rare to see a definite cap or ring. I have one or two clutches in which the blotches are fairly bold but as a rule they seldom contrast strongly with the ground colour. The average of one hundred eggs in 41.1 x 29.4 mm.; maxima *46.1* x 30.6 mm. and 42.0 x *31.7* mm.; minima *88.1* x 29.0 mm. and 39.0 x *28.0* mm.

When sitting the bird is undoubtedly shy but at the same time not so wide awake as either the Red-wattled Lapwing or the Pee-wit, for frequently when wandering slowly along rivers or swamps, I have seen the bird get up from its nest and sneak quietly away. Nor does the cock bird seem to keep a very vigilant watch for intruders, for I have often found a female sitting on the nest without there being any sign of the cock bird watching close by. When disturbed from her nest the female bird does not call until she has got a considerable distance away from it. Incubation I think takes from 22 to 24 days. Three eggs which I found on the third of March had their number increased to four, and all four chicks were hatched on the 28th of the same month. The little birds, although apparently only just hatched, could run with great speed but on being approached and finding escape impossible, lay flat down amongst the small shingle, becoming at once very inconspicuous. When lying thus, they kept their eyes tight shut but after I had stood a few moments watching them, first one eye and then the other eye would open, being promptly closed again when they saw I was watching them. They lay perfectly still until I picked two up, but the other two, which I had been unable to watch closely, immediately scuttled away when unobserved and I was unable to find either. Whilst I was watching them the hen bird kept circling overhead, calling loudly, "Did-he-do-it, did-he-do-it", and was soon joined by the male bird who expressed his indignation in equally emphatic tones.

Habits.—The Spur-winged Plover as a rule keeps either singly or in pairs but I have occasionally seen two or three pairs together, probably attracted by an especially extensive supply of food. In its flight and general actions this plover is very much like the Pee-wit but he keeps more consistently to the banks of rivers and large and small streams. When shooting along these streams the Spur-winged Plover is one of the most annoying birds imaginable, as he not only gives very early notice of one's approach to any big game near enough to hear him but, even after he has done so, insists on accompanying one for a considerable distance up or down the stream, calling loudly every few seconds all the time and many a shot have I missed at big game in consequence of his unwelcome attentions. He flies with very much the same flapping motion as the Pee-wit and is capable of the same speed and activity as that bird on the wing, whilst on the ground he runs with equal celerity. The call is a loud and most persistent "Did-he-do-it, did-he-do-it" generally finishing up with an emphatic, "Yes-he-did ". They swim very well and I have seen tiny chicks not more than a few hours old walk deliberately into a rapid stream and swim across to the opposite shore. They feed very largely on such insect life as they find in marsh lands and the edges of streams, and I have examined birds whose stomachs contained nothing but a mass of caddis worms. They will eat small frogs and tadpoles, crabs and crustacea of considerable size and will pursue and catch small fish cut off in pools of water. The flesh of these birds is quite good, as indeed is that of most of our plovers, and I have more than once enjoyed a stew of plover as a welcome change from the eternal Indian chicken.

GENUS: LOBIVANELLUS.

Lobivanellus Gray.—List. Gen. Genera Birds, 2nd ed., p. 84, Sept. 1841. The no. of the P.Z.S. containing this name was not published until October 1841.

Type by orig. desig., *Parra gœnsis* Gmelin = *Tringa indica* Bodd.

This and the next two genera are distinguished by having curious fleshy wattles in front of the eye, whilst in this also there is a small hind toe present. The bill is of moderate length, the culmen flattened at the base and the dertrum slightly swollen; the linear nostrils are placed in grooves extending over more than half the length of the upper mandible; the wing is long, with the second primary, longest in both sexes, is furnished a spur at the bend; the tail is almost square; the tarsus is long and reticulated throughout.

GENUS: LOBIVANELLUS.

Key to Subspecies.

A. A white band down each side of the neck to the breast.
  a. Slightly darker and with more purple gloss ... ... *L.i. indicus.*
  b. Slightly paler and with less purple gloss ... ... *L.i. aigneri.*
B. A white band from eye to ear-coverts only, lower neck black all round ... ... *L.i. atronuchalis.*

LOBIVANELLUS INDICUS INDICUS.

The Indian Red-wattled Lapwing.

Tringa indica Bodd., Pl. Enlum., p. 50 (1783) (Goa).

Sarcogrammus indicus. Blanf. and Oates, iv, p. 224.

Vernacular Names.—*Titiri, Titar, Titi, Tituri* (Hind.); *Titavi,* (Mahr.); *Yannapa Chitawa* (Tel.); *Al-kati* (Tam.); *Kirala, Kibulla,* (Cing.); *Balighora, Tata-tua* (Assam).

Description.—A broad white band from the eye, including the ear-coverts, passing down the side of the neck and joining the white of the lower breast, abdomen, vent and under tail-coverts; remainder of head, fore-neck and breast glossy black, back, scapulars and innermost secondaries olive bronze-brown, with a purple gloss on the lesser and median wing-coverts; lower back darker brown; rump, upper tail-coverts and tail white, the last with a broad subterminal black bar, the central feathers with brown tips and a brown margin to the black band; primaries and outer secondaries black, the secondaries with broad white bases, which increase until the central rectrices are all white; primary coverts black; greater coverts white with concealed black bases; axillaries white.

Colours of soft parts.—Iris red to red-brown; bill-tip black, the rest red or orange-red; eyelids and wattle crimson-red; legs bright yellow.

Measurements.—Wing 212 to 233 mm.; tail 107 to 116 mm.; tarsus about 79 to 89 mm.; culmen 32 to 34 mm.

Young birds have the black feathers of the head broadly fringed with brown; the chin, throat and fore-neck are white and the sides of the neck not so pure a white as in the adult.

Nestling in down.—Upper parts grizzled grey-brown, white and a little rufous; there are well-marked central and lateral coronal black streaks, a big black patch on both sides of the anterior crown, meeting behind; a well-marked dorsal line and two short black thigh-lines; sides of head and neck white; throat and fore-neck black; remaining underparts dull white.

Distribution.—The whole of India and Ceylon except Sind, Mekran and the Baluchistan frontiers on the west and Assam south of the Brahmapootra and the extreme eastern districts of Bengal, north-east of the Bay of Bengal.

Nidification.—The Red-wattled Lapwing breeds wherever found throughout the Plains and up to an elevation of nearly 5,000 feet, though perhaps not very often above 3,000 feet. Its normal breeding season is March, April and May, but fresh eggs may be found up to August and I have personally taken eggs in the last week of February, and, on several occasions, in March. The favourite nesting site undoubtedly is the bank of some river or an island in the middle of it, though they are not particular as to where they deposit their eggs so long as there is water within easy distance. They breed in almost any kind of open country that is not dry, and very often select a most curious position for their nest. Ballast of railway-lines is quite a popular resort for these birds during the breeding season and Hume records the following:—

> "Going along the line at Etawah for about three miles on 14 August, we found five nests, one containing perfectly fresh eggs. Four of these nests were on the kunker ballast within two feet of the rail, so that the foot-board of the carriages of every train must have passed over and within two feet of the sitting bird. The fifth was on the top of the boundary bank, the bird was sitting totally unconcerned as our trolly passed within six or eight feet of it, and only moving when I walked up to the spot. Brooks tells me that along his fifty miles of line he has seen at least one hundred nests within the last twenty days or month."

The same author records eggs as having been found in an old brick kiln, on the top of hedge banks and even on the top of two-storeyed houses. On the last-named position they hatched their young and in two days had them down in the garden, though how they were transferred from the parapet of the roof, 40 feet from the ground, Hume could not ascertain. Mr. A. Anderson also records an instance of this lapwing breeding on the top of a building, a pair having laid three clutches of eggs between the first week of May and the third week of June. These were, however, all taken, so nothing was discovered as to how the birds take down their young to ground level. Most of the eggs I have found myself have been on sandbanks in rivers and, though they often breed more or less in company with various gulls, terns and other plovers, they seem to prefer sites which are gravelly or rocky, so that whilst other birds may be found breeding on the sandy shores of the river, the eggs of this plover will be found slightly apart, on the more shingly portions of the bank. The nest consists merely of a depression scraped in the sand or shingle, or of a natural hollow in the rock, while the lining, if any, in such places is only a collection of wind-blown fragments.

On the other hand, I have occasionally found nests in cultivated fields, in which a considerable amount of material had apparently been purposely collected, forming quite a respectable nest.

The eggs are quite typical plovers' in appearance, almost invariably numbering four in a clutch. In shape they are broad, slightly peg-top ovals and in colour much the same as the eggs of the Pee-wit, though I think on the whole they are duller and more profusely marked. The ground colour varies from pale yellowish or reddish stone colour to a comparatively deep reddish buff. Others have a pale olive ground tint or, more rarely, greyish stone. The markings are nearly always deep brown or black, consisting of blotches, smudges, spots and scrawls scattered over the whole surface, sometimes forming a more definite cap at the larger end. Most eggs have also secondary markings of lavender, grey, or pale inky. One clutch in my collection has the ground colour an almost bright buff, whilst the markings are of chestnut.

A hundred eggs average 42.1 x 29.8 mm.; maxima 45.8 x 31.0 mm. and 43.4 x 32.2 mm.; minima 39.3 x 28.0 mm.

The parent birds are very shy and nearly always sneak quietly off their nests before the intruder can spot them, but in defence of their young or eggs they are very bold, and I have seen them bravely attacking both kites and jungle crows, when these approach too near their nests. Miss Cockburn says that she has known them attack people taking their eggs, while that they will drive away dogs and jackals from the vicinity of their nests. If disturbed suddenly from their nests, the birds will feign illness and attempt to distract the attention of the intruder and, when once their young are hatched, will circle overhead, uttering loud calls and making swoops in their attempt to drive the intruder away.

Habits.—The Red-wattled Lapwing is one of the most common and most widely spread of the Indian *Charadriidæ*, and wherever he is seen, makes himself conspicuous by his loud cry, "Did-he-do-it," or "Pity-to-do-it." When not breeding and not persecuted they are very tame and allow a very close approach but, if at all shot at, they at once become the wildest and most astute of birds. They are fond of perching on little eminences, from which they can look all round and, on the approach of any danger, down go head and tail and they scuttle into safety at a great pace, as a rule not rising into the air until they have gone a considerable distance. The flight, like that of other plovers, is normally slow and flapping, though the bird is capable of great speed and has wonderful powers of twisting about in the air. In former times it used to be a very favourite quarry for the smaller hawks employed by Indian falconers, its extraordinary antics in the air often completely baffling the swift swoops of the falcon.

Its food consists of worms, grubs, insects of all kinds, as well as fresh water mollusca, tiny crayfish, etc. I have seen them feeding on tadpoles and a flight of termites is as great an attraction to these birds as to nearly all others.

It is resident wherever found although it may desert certain parts of the country if there is an unusual drought, whilst in winter it deserts the higher hills for the plains.

LOBIVANELLUS INDICUS AIGNERI.

The Mekran Red-wattled Lapwing.

Sarcogrammus indicus aigneri Laubm., "Falco" Aug. 1913, p. 30 (Mekran).

Sarcogrammus indicus. Blanf. and Oates, iv, p. 224 (part).

Vernacular Names.—Tatihar (Mesopotamia).

Description.—This race is slightly paler on the upper parts than the typical form and has less gloss both on the back and on the wings. The differences in colour are, however, very slight and there are exceptional specimens from both Mekran and Mesopotamia with as much bronze-green gloss on the back and purple gloss on the wing-coverts as on any Indian bird.

Colours of soft parts as in the other races.

Measurements.—Wing 221 to 240 mm.; one 213 mm.; culmen 31 to 35 mm. (Ticehurst). In the British Museum series the wing runs from 228 to 240 mm.

Distribution.—Mekran, Sind, the extreme North-west Frontier close to Baluchistan and Afghanistan, roughly the Trans-Indus area. The whole of Mesopotamia and South-west Persia.

Nidification.—This Lapwing breeds throughout its area, from Sind to Northern Irak, depositing its eggs in the usual hollow, either natural or scraped out by the bird itself. Scrope Doig took many nests in Sind between March and the end of July and Mr. K. Eates took a large series between the 17th of April and the third week in June, reporting the bird as an extremely common one along the banks of the Hub river, where on several occasions he found many nests containing four eggs on the same day. Most of the nests are built fairly close either to a river or some other piece of water, but this race of Lapwing does occasionally breed further from water than does its Indian cousin. At the same time its eggs will very seldom be taken in really desert country. In appearance the eggs differ in no respect from those of the preceding bird and the average of 50 eggs is 42.4 x 30.4 mm.

Habits.—There is nothing calling for remark in the habits of this bird. It is not perhaps so restricted to well-watered areas as the Indian bird but does not appear to be found in true desert. Ticehurst says:—

> "Throughout the length and breadth of Sind the Red-wattled Lapwing is common and well known to all. Its only essential requirement is fresh water or swamps, or, at least, irrigated fields; hence, wherever there is cultivation, or where some little trickle from a desert spring allows the neighbouring soil to maintain a certain amount of dampness, the inevitable pair or so of

these birds will be found, while round jheels, canals, etc., it is of course common. It is quite resident and not sociable, and I do not ever remember seeing more than could be accounted for by a family party, and each pair is jealous of its own terrain."

Lobivanellus indicus atronuchalis.

The Burmese Red-wattled Lapwing.

Lobivanellus atronuchalis (Blyth), Jerdon, B. of Ind., iii, p. 648 (1864), (Burma).

Sarcogrammus atronuchalis. Blanf. and Oates, iv, p. 224.

Vernacular Names. *Titidu* (Burm.); *Dao-duyip* (Cachari).

Distribution.—Differs from the two preceding races in having the white line down the side of the neck restricted to a patch on and just behind the ear-coverts, leaving the whole neck black all round; the black neck is divided from the green back by a narrow white or lilac band.

Colours of soft parts as in the other races.

Measurements.—Wing 200 to 221 mm.; culmen 27 to 32 mm.

Distribution.—Assam, south of the Brahmapootra, Tippera, Chittagong, Burma and Malay States to Sumatra and the Indo-Chinese countries.

Nidification.—This race of Red-wattled Lapwing breeds principally during April and May but I have eggs taken as early as the 17th of March and one clutch as late as the 22nd of July, this, probably, being a second laying. The birds breed both on the shores and islands of rivers and in cultivated and fallow fields at some distance therefrom. It nowhere appears to be as common as either of the two preceding birds. It ascends the hills to some height and I have taken its eggs in Gachar on the Kopali stream at an elevation of some 1,500 feet, whilst Harington, Grant and Hopwood took them higher than this in the Bahmo Hills. Normally the nests and eggs are just like those of its cousins but I once found four eggs in a rather unusual place—the footmark of a huge tiger on a sandbank. The size of the tiger's tracks had struck me as so extraordinarily large that I was following them up in the endeavour to get a clean mark to measure and, as I did so, the lapwing jumped up and ran along ahead of me and I found the eggs as described. Another rather curious position from which I once took eggs was the upper surface of a large semi-rotten log that lay on the drift left by a hill stream. In Burma they are said frequently to deposit their eggs on the bare soil of paddy fields from which the rice has already been reaped. The eggs do not, I think, vary in any way from those of the other races except that they are on the whole rather darker, possibly to match the darker soil of Burma on which they are laid.

Thirty-six eggs average 41·5 × 29·8 mm.; maxima 45·4 × 30·1 mm. and 45·0 × 31·1 mm.; minima 40·1 × 28·4 mm. and 40·4 × 28·1 mm.

Habits.—The habits of this race differ in no way from those of the others. It is equally noisy and equally a nuisance to sportsmen wandering along the banks of rivers and hoping for bigger game as, like the Spur-winged Plover, they not only are not content with shouting loudly when first disturbed but continue to follow the sportsman and noisily protest against his presence, for some distance.

The flesh of this bird, as well as of the other races, is quite good eating but it can hardly be called a sporting bird and certainly should not be shot for food unless one is very hard up for a dinner.

Genus: LOBIPLUVIA.

Lobipluvia Bonaparte, Com. Rend. Acad. Sci. Paris, xliii, p. 418 (1856).

Type by mon., *Charadrius malabaricus* Boddaert.

In this genus the bill is more slender than in *Lobivanellus,* whilst the tarsus, which is long and slender, instead of being reticulated throughout, has transverse shields in front. There is no hind toe in this genus. Second primary generally longest in both sexes, first and third subequal. Occasionally the first primary is longest but there appears to be no sexual difference in the shape of the wings.

LOBIPLUVIA MALABARICA.

The Yellow-wattled Lapwing.

Charadrius malabaricus Bodd., Pl. Enlum., p. 53 (Malabar Coast).

Sarciophorus malabaricus. Blanf. and Oates, iv, p. 226.

Vernacular Names.—Zirdi (Hind.); *Jithiri* (N.-W. Provinces); *Chitawa* (Tel.); *Al-kati* (Tam.).

Description.—Line between wattles on forehead and crown black, surrounded by a whitish line; back, scapulars, wing-coverts and innermost secondaries light brown; upper tail coverts and tail white with a broad black subterminal band, absent on the outermost pair of feathers and represented by two small black patches on the next pair, central tail-feathers with brown tips and brown edge to the black band; primaries black, the first three with white inner halves to the inner webs; outer secondaries white with a black tip, this decreasing until the central secondaries are all white; greater coverts white; primary coverts black; chin and upper throat black; neck all round paler brown than the back, darkening on the breast and with a black line dividing it from the white lower breast, abdomen, flanks and under tail-coverts.

Colours of soft parts.—Iris white to silver-grey or pale lemon-yellow; bill black, the base and gape yellow, or greenish-yellow; legs and feet bright yellow.

Measurements.—Wing 184 to 202 mm.; tail 80 to 89 mm.; tarsus about 55 to 61 mm.; culmen 26 to 28 mm.

Young birds are pale sandy-brown above, narrowly barred with rather darker brown; chin albescent, throat and upper breast pale brown with faint traces of darker brown marks.

Distribution.—All India and Ceylon, as far north-west as Lower Sind but not in Upper Sind or the Trans-Indus area. East it extends as far as Calcutta and Dacca.

Nidification.—The Yellow-wattled Lapwing breeds over the great part of its area during March, April and May, but on the Travancore coast Messrs. Stuart and Bourdillon found eggs from the 3rd March to the 13th August, and in almost equal numbers throughout the whole of this time. I think most birds prefer ploughed fields, muddy shores of lakes, swamps and rivers, or waste lands in which to breed. At the same time, whatever site they may select will always be dry and, even when the bird breeds on the shores of swamps and tanks, it does so on the sun-baked mud, well away from the water. In the South of India it certainly seems often to choose the sites last-named, whilst in Northern India it selects in preference dry uplands. The nest is the usual depression in the soil, either natural, or made by the birds themselves; in most instances no lining at all is present but occasionally a few scraps of grass or leaves may be found in it. Protection in the form of bushes, grass or clods is sometimes sought but very often the eggs are placed absolutely in the open, although from their colouration they are very inconspicuous and difficult to find. The normal colouration of this plover's eggs is very similar to that of the red-wattled lapwings, but there is a very curious erythritic form which seems exclusive to this species. This red type of egg appears to be a most wonderful instance of environmental selection. Along the Malabar Coast, stretching into Travancore, there is a long, comparatively narrow, strip of red laterite soil. Roughly speaking, the soil looks as if composed of broken red brick, the whole surface scattered with tiny to medium-sized nodules of black ironstone. Throughout this area of red laterite, the eggs laid by the Yellow-wattled Lapwing are exactly like the ground upon which they are deposited, that is to say, the ground colour of the egg is anything from pale to deep buff red, whilst the markings consist of the usual dark blackish brown or reddish brown specks and blotches numerously scattered over the whole surface of the egg. When *in situ* in their nest, the eggs are practically invisible.

The discovery of this wonderful breeding ground is due to Mr. J. Stuart. In 1915 whilst searching very successfully for the ordinary form of this bird's eggs on the black soil which covers most of Travancore and Malabar, he obtained on a patch of red laterite a set of eggs of the red form. This he very kindly sent home to me. In the following year he deputed men especially to work the larger area of red laterite, similar to that on which he had obtained the first eggs. The first year neither he nor his men were very successful though the few sets they did find were all of the erythritic type. Mr. Stuart however believed that when his eyes got more accustomed to the curious similarity between the eggs and their surroundings, he would be more successful. Accordingly he and his men persisted in their search in subsequent years and eventually got a magnificent series of these eggs. The birds, he found, were quite as numerous on the red laterite soil as they were in the black surrounding country but, whereas in the latter, practically every egg taken was of the normal dark, earthy type, those obtained on the red laterite were with almost equal constancy of the erythritic type. On the rare occasions on which eggs were found on soil contrasting with their colour, they stood up so conspicuously that it was obvious they must have speedily attracted the attention of vermin passing anywhere close by.

It would appear as if, in this instance, the Yellow-wattled Lapwing had become so common on its normal breeding ground of black soil that some of the birds had been pushed into the red laterite, where they had perforce to breed. At first their eggs must have been regularly destroyed by vermin, but amongst the many eggs laid it is probable that some had a certain amount of reddish tinge which rendered them less conspicuous than the others and they thus escaped destruction. In the course of time, as each generation of birds developed, the eggs of those which were more reddish than the rest would survive in greater proportion and thus, eventually, by gradual elimination, only those would be left which laid eggs sufficiently red to ensure the continuation of its kind. It is an extraordinary fact that prior to Mr. J. Stuart's discovery, the very well-known ornithologist, Mr. J. Davidson had twice obtained erythristic eggs of this bird and, when I wrote to tell him about Mr. Stuart's discovery, he mentioned in his reply that he had found two clutches himself and that in each instance the eggs had been taken from a soil he believed was red laterite, which rendered them almost invisible, but that in each case he had had his attention drawn to the place where they were laid, by the female bird getting up and running away. The number of eggs laid seems to be almost equally often three or four, and that the threes are not incomplete clutches is shown by their frequently being incubated. Two hundred eggs average 36·4 × 26·9 mm.; maxima *42·8* × 26·0 mm. and 37·0 by *28·5* mm.; minima *32·0* × *24·4* mm.

Habits.—The Yellow-wattled Lapwing is essentially a bird of dry open country and even though it is more common on the very wet Malabar Coast than anywhere else, it keeps in that area to the drier and more open districts rather than to the wetter, heavily forested country. Stuart says that it is most numerous in the vicinity of the lakes but that it is always found well away from the muddy shores, whilst in Northern India it is often found at great distance from water, which does not seem to be a necessity to this plover as it is to the Red-wattled Lapwing. Its flight is very similar to that of the latter bird but it does not indulge so often in aerial tricks, though at the beginning of the breeding season it constantly rises into the air and goes through the usual motions beloved of lapwings. Its food is principally insectivorous but it eats practically any small living thing such as worms, grubs, small lizards, frogs, etc. Its flesh is quite good eating but, though it is a shy bird in some parts and might take a little care before a sportsman could approach within shot, it certainly cannot be considered a game bird.

Genus: MICROSARCOPS.

Microsarcops Sharpe, Cat. B.M., p. 133 (1896).
Type by mon., *Pluvianus cinerea* Blyth.

This genus is very close to the preceding but has a small hind toe. There is a lappet as in that genus and the long, slender tarsi are reticulated behind and scutellated in front.

The genus contains but one species which summers from Mongolia to Japan, migrating as far as India in the cold weather.

MICROSAROPS CINEREUS.

The Grey-headed Lapwing.

Pluvianus cinereus Blyth, J.A.S.B., xl, p. 587 (1842) (Calcutta); Blanf. and Oates, iv, p. 228.

Vernacular Names.—None recorded.

Description.—Upper plumage from forehead to lower back light brown, the forehead almost or quite pure grey and the head to the nape washed with grey; wing-coverts edged paler and grayer; rump, upper tail-coverts and tail white, with a broad black subterminal bar, almost disappearing on the outermost feathers and bordered with brown on the central ones; primary coverts and primaries black; greater secondary coverts and secondaries white; chin albescent; whole neck and upper breast ashy-grey, terminating in a broad chocolate-black pectoral band; under wing-coverts, axillaries and under tail-coverts white.

Colours of soft parts.—Iris red; bill yellow with the terminal third black; eyelids and lappets yellow; legs and toes brownish-yellow or yellow; claws black.

Measurements.—Wing 228 to 255 mm.; tail 93 to 112 mm.; tarsus about 75 to 79 mm.; culmen 35 to 39 mm.

Young birds have the head, neck and breast concolorous with the black and want the pectoral band.

Distribution.—Breeding from Central Siberia and North-west China to Japan and Corea; wintering in Southern China, the Indo-Chinese countries, Malay States, Burma and Eastern India. Irby reported it from Oude, probably quite correctly, whilst recently Whistler saw it in Kashmir, so close that, although he did not shoot it, he is positive as to its identity. In Assam and Eastern Bengal it is quite common from November to March and I have shot many in the former Province. It has also occurred in the Andamans.

Nidification.—There is very little on record about the breeding of this Plover. According to Dresser it is said to breed in April, depositing its four eggs in the grass of intersecting ricefields. Two clutches, each of three, in my own collection, were laid, one on the fourth of June in Korea and the other on the fourth of May in Eastern Manchuria. These two clutches and a few others I have seen are indistinguishable from the eggs of the Common Pee-wit, except that they average decidedly smaller, although the bird itself is as big or bigger. Probably, moreover, a larger series would show a much bigger average size. My clutch of eggs taken in Manchuria was said to have been laid in a nest in short coarse grass in a swampy field, whilst the others given to me by Dr. Paul Leverkhun were deposited in a scratching among the grass on a bit of raised land in a ricefield. One of my clutches is possibly unusually well marked, having a pale buff ground colour with bold blotchings of dark umber brown, fairly numerously distributed over the whole surface here and there, with smaller secondary markings of inky brown and a few underlying of lavender. The other clutch has a comparatively dark brown ground colour, profusely covered with blotches, spots and smears of brown, one egg again having a considerable number of secondary markings of grey. Dresser describes the eggs as being less pointed than those of the Lapwing but both my clutches are distinctly pointed. Eight eggs average 41·3 by 32·6 mm.; maxima *49·6* × *34·0* mm.; minima *41·0* × *30·0* mm.

Habits.—The habits of this Plover seem to be very similar to those of the Common Pee-wit but it is more addicted to swamps, lakesides, ricefields and wet ground generally rather than the higher uplands. In Assam, when we came upon them they were almost invariably in the wet ground round marshes and we occasionally shot one when snipe-shooting. They did not appear to be nearly as wild as most plovers and were not difficult to approach within shot. We never came across them in flocks, generally singly and occasionally in pairs. Their flight was much like that of the pee-wit but perhaps less slow and flapping and rather straighter. Two we ate were very palatable, tasting much the same as Golden Plover. The only cry we heard was a plaintive "Chee-it, chee-it", and even this was very seldom uttered. They arrive in north-eastern India about the middle or end of October and disappear again before the end of March, though I once saw one during the first week of April.

REVISION OF THE FLORA OF THE BOMBAY PRESIDENCY.

BY

E. BLATTER, S.J., Ph.D., F.L.S.

PART XVI.

(*Continued from p. 30 of this volume*).

ORCHIDACEÆ.

BY

E. BLATTER & C. McCANN, F.L.S.

(*With 8 plates and 6 text figures.*)

The key to the genera will be given at the end.

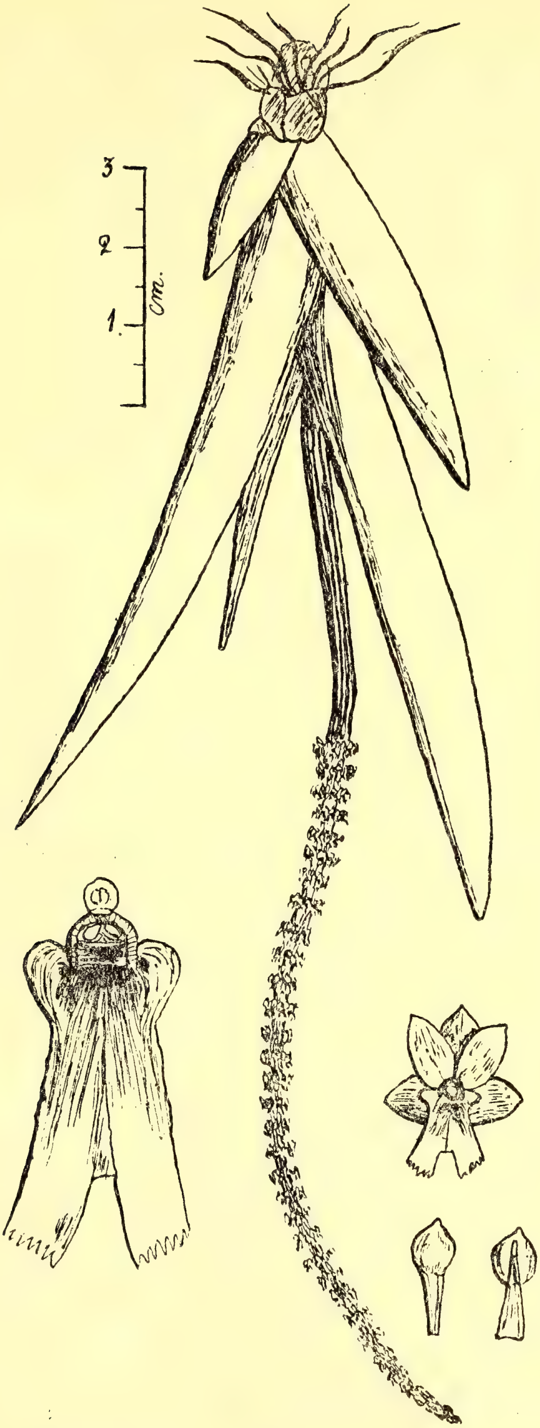
1. OBERONIA Lindl.

Species about 100—Palæotropics.
Cooke mentions 3 species. We add 6 new species and 5 not recorded from the Presidency, before.

Key partly based on Fisher, Fl. Madras.

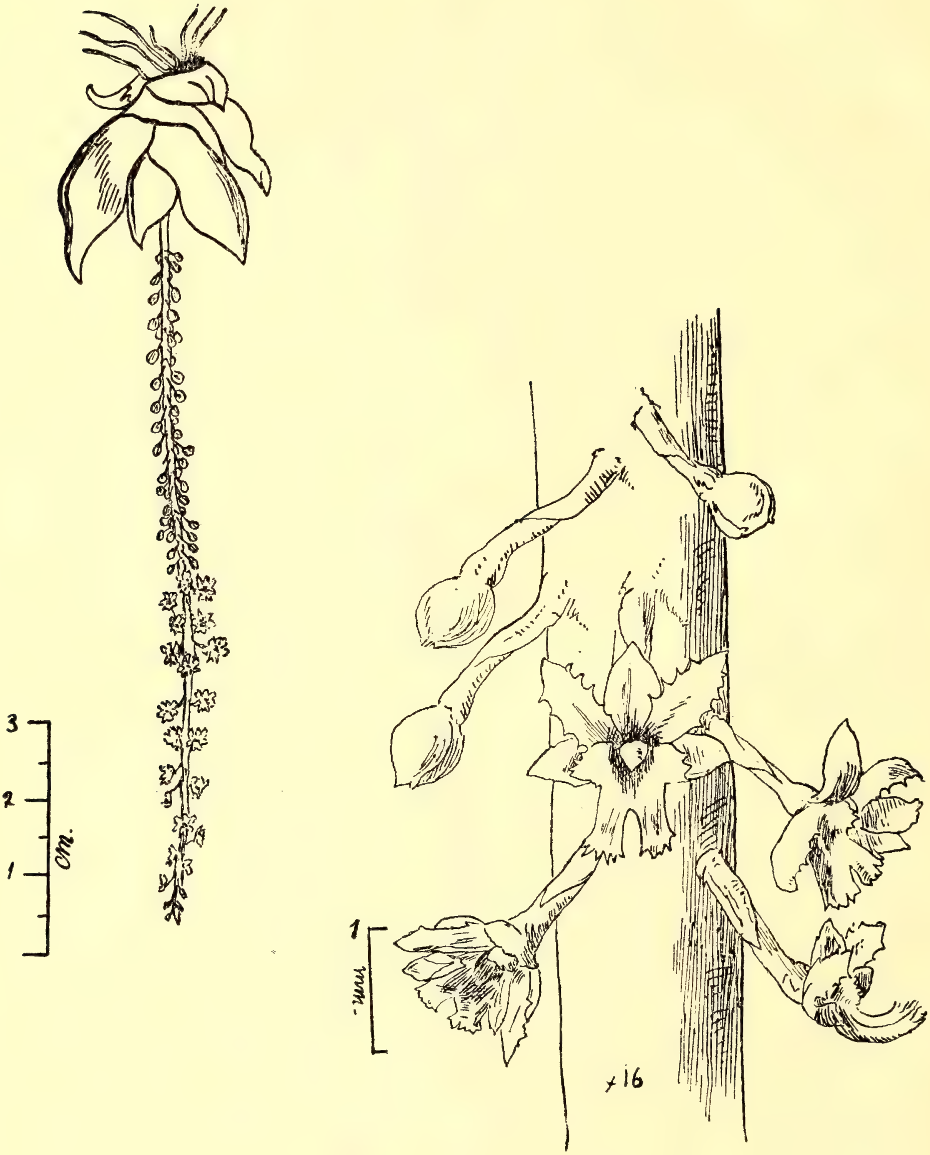
- A. Sepals subequal.
  - I. Petals broad, elliptic-oblong or ovate.
    - 1. Side lobes of lip absent ... ... 1. *O. verticillata.*
    - 2. Side lobes of lip very small
      - (*a*) Lip obcordate with 2 triangular truncate slightly diverging lobes, sinus subacute or obtuse ; side lobes very minute ... ... 2. *O. lingmalensis.*
      - (*b*) Lip oblong, erose, bifid with strap-shaped slightly divergent obliquely truncate segments, sinus $\frac{1}{3}$ the whole lobe ; side lobes very small, rounded ... ... 3. *O. Bellii.*
      - (*c*) Lip obcordate with subrotund angular divergent lobes and a broad rounded sinus. Side lobes minute. Flowers spirally arranged ... 4. *O. spiralis.*
      - (*d*) Lip oblong with 2 short narrow acute lobes, separated by a broad sinus ; side lobes small, rounded or tooth-like. Flowers not verticillate ... 5. *O. Falconeri.*
      - (*e*) Lip obcordate, quadrate, 2-lobulate at apex, with a narrow sinus, lobules oblong, dentate at apex ; side lobes small, rounded, dentate at apex ... 6. *O. brachyphylla.*
    - 3. Side lobes of lip large, orbicular ; midlobe obcordate, 2-lobulate ... ... 7. *O. recurva.*
  - II. Petals linear. Lip distinctly lobed.
    - 1. Scape adnate to the upper leaf.
      - (*a*) Lip orbicular with a 2-lobed apical auricle. Flowers sessile, densely imbricate ; lip with a concave disk 8. *O. Brunoniana.*

Plate I.



Del. C. McCann after Miss E. Bell.

Oberonia Bellii, Blatter & McCann, *sp. nov.*


3
2
1
cm.
1
mm.
×16

Oberonia brachyphylla, Blatter & McCann, *sp. nov.*

(*b*) Lip with a short 2–3-fid midlobe; lateral lobes broad, rounded. Flowers sessile, large (5 mm. diam.), densely imbricate ... ... 9. *O. platycaulon.*
(*c*) Lip without side lobes, midlobe ovate-rotund with 2 acute or acuminate parallel processes at the tip, with a more or less narrow and deep sinus 10. *O. Sedgwickii.*
2. Scape not adnate to the upper leaf.
(*a*) Midlobe of lip much smaller than the lateral lobes, broad. Lip broadly 3-lobed, crenate, gland-dotted ... 11. *O. Lindleyana.*
(*b*) Midlobe of lip much longer than the lateral, narrow
† Lateral lobes of lip very broad, ovate, obtuse ... . 12. *O. Arnottiana.*
†† Lateral lobes of lip ligulate ... 13. *O. Wightiana.*

B. Sepals very unequal, dorsal ovate-lanceolate, lateral obliquely and broadly ovate-subrotund ... ... 14. *O. umbonata.*

1. **Oberonia verticillata**, Wight Ic. t. 1626; Lindl. Fol. Orch. Oberon. 3 (*excl. aliquibus var.*); Hook. f. in F.B.I. vi, 678. *Malaxis verticillata* Reichb. f. in Walp. Ann. vi, 211.

This species is not mentioned by Cooke. We give first the description as we find it in the F.B.I. and Wight.

Description: Scape 2·5–5 cm., terete. Leaves 5–10 cm. by 4–8 mm., narrow, ensiform, subfalcate, acute or acuminate. Racemes long, 10–15 cm. long, erect or decurved. Flowers whorled pedicelled, pale yellow (Hooker), 2·5–3 mm. long. Bracts ovate-lanceolate, acute, erose on the margin, about equalling the pedicels. Sepals short, broad, ovate, obtuse, pale green. Petals oblong (Hooker), subobovate (Wight), obtuse, longer than the sepals. Lip twice as long as the sepals, oblong, slightly cordate at base, 2-lobed at apex, lobes broad, roundish, spreading, slightly crenulate on the margin. Ovary pale green. Capsule pedicelled.

We add the following details observed in fresh material:

Scape channelled. Bracts right down to the base amongst the leaves, all scarious. Flowers in whorls of 5, but not exactly at the same height, greenish orange, the base of lip deeper orange above. Column long; anther posticous-terminal, cap green, oval.

In the type the bracts are only as long as the pedicels. This is not the case in a specimen collected by Bell, of which we make a variety:

Var. longibracteata Blatter & McCann *var. nov.-Bracteæ floribus æquilongae.*

Locality: N. Kanara: Yellapur, 1,500 ft., rainfall 100 in. (Bell 3908! type, 217!).

Flowers: End of September and October.

Distribution of species: W. Ghats of Madras Presidency, Nilgiris, Pulneys, Salem Hills.

2. **Oberonia lingmalensis**[1] Blatter & McCann, *sp. nov.*

[*Includitur in sectione Oberoniæ proprie dictæ. Similis Oberoniæ verticillatæ* Wight, *a qua tamen differt scapo complanato, bracteis lineari-subulatis minime erosis et variæ longitudinis, floribus longe-pedicellatis, petalis erosis.*]

Description: Scape a few mm. long, flattened, adnate to the side of a leaf, with a few hyaline subulate bracts. Leaves many, ensiform, acuminate, falcate or straight, in the same specimen, up to 7–9 cm. by 15 mm., thin. Raceme up to 9 cm. long, 3–4 mm. diam., very dense and uniformly thick throughout, decurved or straight; rhachis slender, channelled. Flowers long-pedicelled, verticillate or subverticillate; pedicels very slender, 2 mm. long including the ovary. Bracts linear-subulate, hyaline, entire, mostly shorter than the pedicel, but also as long or longer than the pedicel, even as long as the whole flower. Lateral sepals broadly ovate, subacute or obtuse. Dorsal sepal much narrower, subacute. Petals oblong, slightly oblique, erose, slightly longer than the dorsal sepal. Lip obcordate, longer than the sepals, side lobes very minute, midlobe erose, divided into 2 triangular-truncate slightly diverging lobes, sinus subacute or obtuse. Capsule 3-4 mm. long, pedicelled, pedicel about 1·5 mm. long, thickened.

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[1] Lingmala is near the Yenna waterfall a few miles from Mahableshwar on the road to Panchgani.

Locality : W. Ghats : Lingmala near Mahableshwar, on trees (Blatter and Hallberg P 1681 ! type, Sedgwick 7755 !, 4626 !) ; Kamelgad, below Fort (Fernandez !).—*Konkan :* Thana forest (Bell 3973 !).—*N. Kanara :* In forests (Bell 5406 !).

Flowers: February 1918 (N. Kanara) ; November 1918 (Lingmala) ; January 1925 (Lingmala) ; October 1920 (Lingmala). *Fruit:* January 1925 (Lingmala).

3. **Oberonia Bellii** Blatter & McCann, *sp. nov.*

[*Pertinet ad sectionem Oberoniæ proprie dictæ. Accedit ad Oberoniam verticillatam a qua tamen recedit rhacheis 8-sulcatis, bracteis, lanceolatis fimbriatis aliquantulum gemmis longioribus, floribus sessilibus petalis ovato-oblongis, labio oblongo lobo medio bifido eroso segmentis ligulatis apice oblique truncatis.*]

Description : Scape together with raceme almost twice as long as longest leaf. Leaves narrow, ensiform, falcate or subfalcate, acuminate, broad at base, up to 10 by 1 cm. Rhachis fairly stout with 8 grooves and 8 rounded ridges between the grooves. Buds globose, apiculate. Flowers sessile, 2 mm. long, verticillate, one flower on each ridge, the ridge of one node being continued by a groove on the next. Internodes 2·5 mm. long. Bracts 2 mm. long, lanceolate, acute, membranous, broadest in the middle, fimbriate, slightly longer than the buds. Sepals ovate-acute, subequal. Petals narrower than the sepals, ovate-oblong. Lip oblong, longer than the sepals, erose, side lobes very small, rounded, midlobe bifid with strap-shaped, slightly divergent obliquely truncate segments, sinus $\frac{1}{3}$ of the whole lobe. Ovary 1 mm. long. Column merely a horseshoe-shaped low wall, covered by the nearly circular lowly convex green smooth little cap. Pollinia extremely minute, orange-yellow, pear-shaped ; point of attachment short and pointed (fixed to a minute surface at each end of horseshoe rim of column).

The pollinia fall out when the flower is ready, the cap raising itself for the purpose. The hollow in the front of the column is square (Bell).

Description and illustration from Bell's MS.

Locality : N. Kanara : Yellapur (T. R. Bell).

Flowers : March 1912.

4. **Oberonia spiralis** Blatter & McCann, *sp. nov.* (*non* Griff.).

[*Pertinens ad sectionem Oberoniæ proprie dictæ accedit ad Oberoniam verticillatam* Wight, *sed differt foliis crassis, floribus interrupto-spiraliter dispositis, bracteis fimbriatis floribus æquilongis vel iis longioribus, labii lobo centrali bilobo sinu lato rotundato intermisso.*]

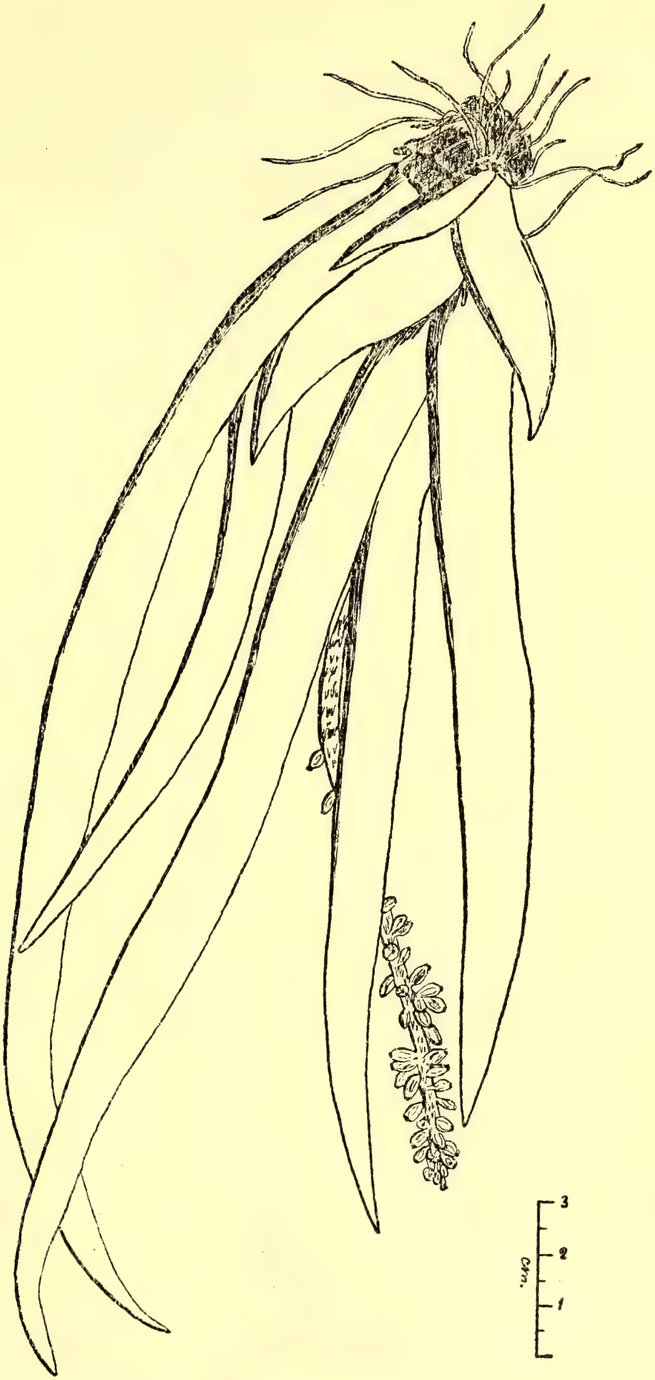
Description : Scape short, terete, lower 2 cm. ebracteate. Leaves few, fleshy, ensiform, straight or subfalcate, 4–6 cm. by 5–8 mm., broad at base or getting slightly narrower, acute at apex. Raceme 13 cm. long, slender, terete. Flowers pedicelled, densely packed on a left-turning spiral, but the spiral regularly interrupted when the flowers have filled $\frac{2}{3}$ of the circumference, windings close to each other, 27 on 10 cm. of rhachis. Pedicels 1-2 mm. long, pedicels and flowers 3-4 mm. Bracts narrow lanceolate-acuminate, fimbriate, as long as or longer than the flowers. Sepals broad-ovate, unequal, subacute or obtuse. Petals not linear. Lip longer than the petals, obcordate, with subrotund-angular, divergent lobes and a broad rounded sinus between them ; side lobes minute, rounded. Fruit not seen.

Amongst the 'Indeterminable Species' of *Oberonia*, Hook. f. (in F.B.I. v, 686) mentions *O. spiralis* Griff. Notul. iii, 275. As this species wants description and locality and cannot, therefore, be determined, we take it for granted that the name *spiralis* is available.

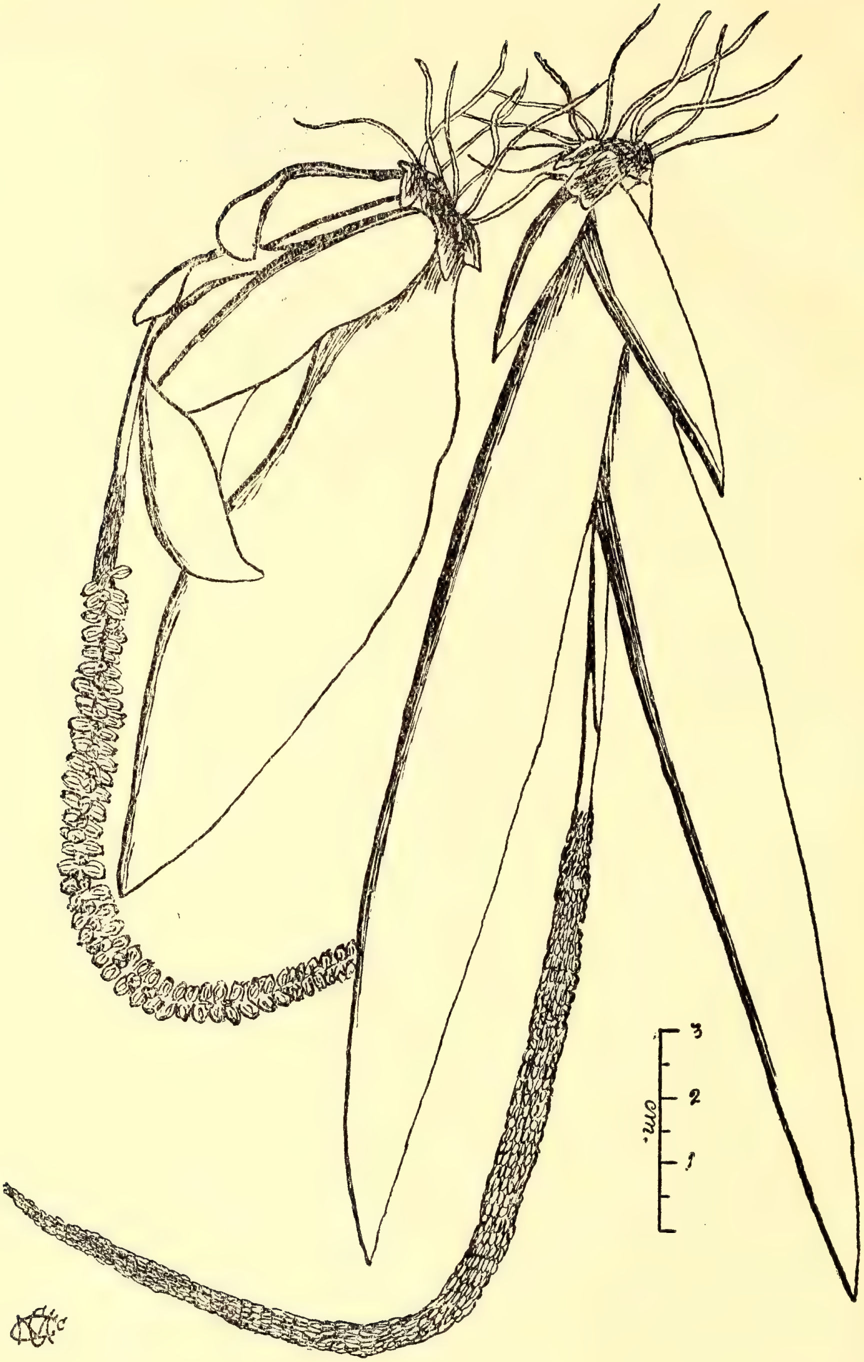
Locality: N. Kanara : Yellapur, rainfall 100 in. (T. R. Bell 219 ! type)

Flowers : October.

5. **Oberonia Falconeri** Hook. f. Ic. Pl. (1888) t. 1780 ; F.B.I. v, 678 ; Cke. ii, 676 ; Duthie Ann. Roy. Bot. Gard. Calc. ix, 2, t. 94.



Del. C. McCann after Miss E. Bell.
Oberonia Brunoniana, Wight.



Oberonia Lindleyana, Wight.

Description : Cke. l.c.
Locality : Konkan (Law, Woodrow !) ; Thana (Ryan 65 !); Kalyan (Millard !).
Distribution : Tropical Himalaya, Kumaon, Nepal, Dehra Dun, Behar, Chota Nagpur, Mysore Hills at 3,500 ft., Rampa Hills at 2,000 ft., Vizagapatam Hills at 2,400 ft.

6. **Oberonia brachyphylla** Blatter & McCann, *sp. nov.*
[*Pertinet ad sectionem Oberoniæ proprie dictæ. Accedit ad Oberoniam recurvam* Lindl. *sed distinguitur foliis ovato-oblongis acutis, non glanduloso-punctatis, racemis longioribus laxis, petalis oblongis subacutis, labio quam sepala multo longiore lobo medio quadrato bifido incurvato.*]
Description : A small plant, 11 cm. high to top of inflorescence. Scape short. Leaves short, 2·5 cm. long, 1 cm. broad, green, ovate-oblong, acute, nearly straight. Bracts very short, shorter than the pedicel, lanceolate, entire. Raceme up to 9·5 cm. long, lax, slender. Bud ovate or globose. Flowers 1·5 cm. across, long-stalked, 1·25 mm. long, not gland-dotted. Sepals broadly ovate, dorsal, one obtuse, lateral acute. Petals oblong, subobtuse at apex, margin dentate. Lip much longer than the sepals ; side lobes small, rounded, dentate at apex ; midlobe quadrate, obcordate, 2-lobulate, incurved with a narrow sinus, lobules oblong, dentate at apex. Fruit not seen.
Description after detailed illustrations from live specimens by Mr. T. R. Bell and Miss Bell.
Locality : N. Kanara (T. R. Bell).

7. **Oberonia recurva** Lindl. in Bot. Reg. (1839) Misc. no. 8 ; Hook. f. Ic. Pl. t. 1784 A ; F.B.I. v, 680 ; King and Pantl. Ann. Roy. Bot. Gard. Calc. viii. t. 9 ; Cke. ii, 676.—*O. setifera* Lindl. l. c. 3.—*Malaxis setifera et recurva* Reichb. f. in Walp. Ann. vi, 210, 212.
Description : Cke. l. c.
Locality : Konkan (Law).—*W. Ghats :* Lonavla (Gammie 12678 !, Hallberg 26553 !) ; Khandala (Law 39) ; Mahableshwar (Cooke !); Mahableshwar to Pratapgad (Agharkar 2 ! Herb. Calc.).
Distribution : Konkan, W. Ghats, Travancore.

8. **Oberonia Brunoniana** Wight Ic. v (1852) 3, t. 1622 ; Lindl. Fol. Orch Oberon. 2 ; Hook. f. F.B.I. vi, 681 ; Cke. ii, 677.—*Malaxis Brunoniana* Reichb. f. in Walp. Ann. vi, 209.
Description : Cke. l. c.—According to Fischer, the sepals and lip are dark brownish, the petals pale yellowish.
Locality : Konkan (Dalzell).—*N. Kanara :* Kalanadi (Ritchie 1405) ; in forests (Bell 5403 !).
Distribution : Nilgiris, Pulneys, Malabar, Travancore.

9. **Oberonia platycaulon** Wight Ic. t. 1623 ; Hook. f. in F.B.I. v, 682 ; Gammie in Journ. Bomb. Nat. Hist. Soc. xvi (1906) 682.—*Malaxis platycaulon* Reichb. f. in Walp. Rep. vi, 239.
Description : Scape very broad, flat, 5-20 mm. broad, very coriaceous, adnate to a leaf to the top. Leaves long, narrowly ensiform, straight, subacute, 15-25 cm. by 12–18 mm. Raceme 7–12 cm. long ; rachis stout. Flowers whitish or pale yellow, large, densely imbricate, about 5 mm. across. Bracts broad, sheathing the sessile ovary, erose, acute. Sepals ovate, lanceolate, acute. Petals narrow, slightly shorter than the sepals ; lip broader than long ; lateral lobes broad, rounded, midlobe very short, bifid or 3-fid. Fruit sessile.
Locality : Western Ghats from the Konkan southwards (ex Hook. f.).
Distribution : Nilgiris, Pulney Hills, High Wavy Mountains.

10. **Oberonia Sedgwickii** Blatter & McCann, *sp. nov.*
[*Pertinet ad sectionem Oberoniæ proprie dictæ. Accedit ad Oberoniam caulescentem* Lindl. *sed differt foliis oblongis vel ovato-oblongis vel lanceolatis acutis multo brevioribus scapo in parte inferiore bialato, bracteis ovatis, floribus non subverticillatis, labio basi minime lobato.*]
Description : A very small pendulous plant, 2–6 cm. high to top of inflorescence. Scape arising from the side of a central leaf, up to 12 mm. long, lower half 2-winged, upper half clothed with hyaline, ovate-acute, erose bracts. Racemes mostly straight, sometimes flexuose, up to 4·5 cm. long, slender.

Flowers short-pedicelled, scattered, densely arranged. Bracts about the length of the pedicels. Sepals gland-dotted. Dorsal sepal broadly triangular-ovate, acute. Lateral sepals obliquely and broadly ovate-acuminate. Petals linear. Lip without side lobes, midlobe broader than lateral sepals, ovate-rotund, with 2 acute or acuminate parallel processes at the tip with a more or less narrow and deep sinus between them. Capsules (perhaps not quite ripe) 3 mm. long ; pedicels half as long, stouter than the flowering pedicel.

Locality: W. Ghats: Castle Rock, 1,600 ft., rainfall 250 in. (Sedgwick's collector 5615 ! type, 5540 ! co-type).

Flowers and Fruit: March 1919.

11. **Oberonia Lindleyana** Wight Ic. t. 1624 ; Hook. f. F.B.I. v, 681.—*Malaxis Lindleyana* Reichb. f. in Walp. Rep. vi, 210.

Description: Scape compressed, stout, with raceme 10–18 cm. long. Leaves 7–15 by 1·5–3 cm. very fleshy, ensiform, subfalcate, obtuse or subacute, broad at base. Raceme stout, drooping towards the apex, brick-red, densely covered with innumerable small, sessile, densely imbricating flowers. Bracts broadly ovate-obtuse, subdenticulate on the margins. Petals narrow-linear, entire. Lip broad, rather longer than the sepals, cordate at base, crenate, broadly 3-lobed, midlobe broad, much smaller than the lateral ones, all gland-dotted. Capsule small, sessile on the thickened rachis.

Regarding the colour of the flowers, Wight l.c. says : ' Flowers straw colour, lip dull orange.' According to J. D. Hooker l. c. the flowers are ' pale with an orange (?) centre of lip.' The label in Sedgwick's herbarium bears this remark : ' Spike brick-red '. Sedgwick very likely gave the general colour-impression of the spike.

Wight points out that the very succulent leaves and the long drooping raceme form good marks by which this species can be distinguished.

Locality: N. Kanara: Anmod, 1,200 ft., rainfall 200 in. (Sedgwick 3302 bis !); in forests, rainfall 100 in. (Bell 5402 !).

Distribution: N. Kanara, Nilgiris, Travancore Hills.

12. **Oberonia Arnottiana** Wight Ic. 1628.—*O. Wightiana* Lindl. in Bot. Reg. (1839) Misc. no. 9 (*partim*) ; Hook. f. F.B.I. v, 683 (*partim*) ; Fischer Fl. Madras pt. 8 (1928) 1407 (*partim*).

We separate this species from *O. Wightiana* Lindl. and in F.B.I. l. c. Hook. f. thinks that *O. Arnottiana* is a longer-pedicelled variety of *O. Wightiana*. The two are certainly nearly allied, but we think that Wight was correct when he said that the ligulate lateral lobes of the lip of *O. Wightiana* is peculiar and at once distinguishes it from *O. Arnottiana*. This latter species can be recognized by long pedicels, by the rounded ovate-obtuse lateral lobes of the lip, by the racemes not drooping, ciliate bracts and acute sepals.

Description: Leaves short, ensiform, subfalcate or straight, succulent, acute. Racemes erect or very slightly inclined towards the apex, scarcely or not at all drooping. Flowers alternate, longish pedicelled, pale green. Bracts ovate-acute, ciliate, somewhat sheathing at the base. Sepals ovate-acute. Petals narrow-linear, about the length of the sepals. Lip cordate at the base, 3-lobed ; lateral lobes very broad, ovate, obtuse ; midlobe small, prolonged, divided at the apex. Capsules long-pedicelled.

We have avoided giving measures because the specimen at our disposal is evidently a very small form.

Locality: N. Kanara: Anmod, on trees, 2,000 ft., rainfall 200 in. (Sedgwick 3261 !).

Distribution: N. Kanara, Nilgiris, Pulneys.

Flowers and fruit: December 1917.

13. **Oberonia Wightiana** Lindl. in Bot. Reg. (1839) Misc. no. 9 (*partim*) ; Wight Ic. t. 1627 ; Hook. f. in F. B. I. v, 683 (*partim*) ; Fischer Fl. Madras pt. 8 (1928) 140 (*partim*).

Description: Leaves broad, ensiform, acute, straight, rarely subfalcate, 2·5–10 cm. by 4–8 mm. Scape and raceme together 7–15 cm. long, curved or decurved ; scape terete, naked or sparsely bracteate. Flowers pale green, scattered, short-pedicelled. Bracts broad, ovate or oblong, erose at the apex, longer or shorter than the pedicels. Sepals ovate-obtuse. Petals linear, obtuse. Lip 3-lobed ; lateral lobes strap-shaped, embracing the base of the column ;

midlobe prolonged ending in 2 obovate spathulate spreading lobes, crenulate on the margins.

Locality : N. Kanara : Yellapur, hanging on underside of branches, 2,000 ft., rainfall 100 in. (Sedgwick 2488 !) ; Haliyal, 2,000 ft., rainfall 70 in. (Sedgwick 2863 !).

Distribution : N. Kanara, Nilgiris, Pulneys.

Fruit : May 1917 (Yellapur) ; August 1917 (Haliyal).

14. **Oberonia umbonata** Blatter & McCann, *sp. nov.*

[*Pertinet ad sectionem Scyllæ. Accedit ad Oberoniam Scyllæ* Lindl., *sed distinguitur racemis longissimis, bracteis floribus æquilongis vel iis longioribus, sepalo dorsali ovato-lanceolato, petalis oblongis, sepalis lateralibus oblique et late ovato-subrotundis umbonatis, labio lunato.*]

Description : Stem almost 0. Leaves few, up to 6 cm. by 8 mm., straight or subfalcate, thin, linear-lanceolate, acute or acuminate. Scape about 1 cm. long, terete. Raceme up to 13 cm. long, terete, very slender, slightly bent in the upper third. Bracts narrowly lanceolate-subulate, entire (not erose) hyaline, as long as or longer than the flowers. Flowers pedicelled, verticillate, densely arranged. Dorsal sepal ovate-lanceolate, subacute or acuminate, much longer than the lateral sepals, subcucullate. Lateral sepals obliquely and broadly ovate-subrotund, umbonate. Petals oblong, subtriangular and subobtuse at apex, narrower but longer than the lateral sepals. Lip very small, lunate, lateral lobes erect on each side of the column, lanceolate-subulate. Capsules pedicelled, pedicels as long as the capsule.

Locality : N. Kanara : Siddhapur, on a tree, 1,400 ft., rainfall 100 in. (Bell & Sedgwick 7270 !).

Flowers and young fruits in October 1917.

2. MICROSTYLIS Nutt. (Cke. ii, 677).

Species 100.—Asia, America.

We retain the one species mentioned by Cooke.

1. **Microstylis versicolor** Lindl. Gen. and Sp. Orchid. (1830) 21 (*non* Wight). Fischer Fl. Madras pt. viii (1928) 1408.—*Microstylis Rheedei* Wight Ic. iii (1843-45) t. 902 ; Hook. f. F B.I. v, 690 ; Ic. Pl. t. 1832.—*Malaxis Rheedei* Heyne ex Wall. Cat. (1828) *sub.* no. 1939.

Description : Cke. ii, 678.

Locality : Konkan : (Law, Stocks) ; Hills W. of Mullund (McCann !) ; Matheran (Chibber !).—*W. Ghats:* Khandala (Cooke !, Hallberg !, Blatter & McCann 25836 !, 25837 !) ; Lonavla (Garade 11 !) ; Mahableshwar (Cooke !); in forest near Lake (McCann !); Koina Valley below Mahableshwar (Cooke !) ; Panchgani, Third Tableland (Blatter !); Castle Rock, 1,600 ft., rainfall 250 in. (Sedgwick 2810 bis !).—*N. Kanara :* Guddehalli on edge of open spaces in the jungle, 1,000 ft., rainfall 120 in. (T. R. Bell 7869 bis !) ; without locality (Sedgwick 3181 bis !).

A terrestrial herb growing under the shade of trees. Propagation is by two ways, one by seed and the other by budding. The buds may be developed either at the side of the old one or upon the stem or sometimes upon the rachis of the inflorescence. During the dry season the leaves dry up leaving only a stump, but this is only true of plants growing in deciduous forests. Fruits are developed in early October.

Distribution : W. Ghats of Madras Pres. from 6,000 ft. upwards, Chota Nagpur.

3. LIPARIS Rich.

Species about 100.—Tropical and temperate regions.

So far, 1 species was known from the Presidency. We add a new one.

1. Lip 4 mm. long ... ... 1. *L. nervosa.*
2. Lip 8 mm. long ... ... 2. *L. flavo-viridis.*

1. **Liparis nervosa** Lindl. Gen, and Sp. Orchid. (1830) 26 ; Cke. ii, 678 ; Fischer Fl. Madras pt. viii (1828) 1410.—*L. paradoxa* Reichb. f. in Walp. Ann. vi (1861) 218 ; Hook. f. F.B.I. v, 697 and vi, 181 ; King in Ann. Roy. Bot. Gard. Calc. viii, 27, t. 34.—*L. odorata* Lindl. l. c. 26.—*Malaxis odorata* Willd. Sp. Pl. iv (1805) 91 ; Grah. Cat. 202.—*L. Dalzellii* Hook. f. F.B.I. v, 698.—*Liparis nervosa* var. *Dalzellii* T. Cooke Fl. Bomb. ii, 679.

Description : Cke. ii, 67.

Locality : Konkan : (Stocks.)—*W. Ghats :* Londa (Spooner !); Castle Rock, very rare, 1,600 ft., rainfall 250 in. (Sedgwick 2792 !).—*N. Kanara* (Law).

Distribution : Kumaon, Nepal, Khasia Hills, 4,000–6,000 ft., Bengal, Konkan, W. Ghats, N. Kanara, Nilgiris, Anamalais at 3,000 ft., Ceylon.—The species may extend further eastwards, but we are not sure.

J. D. Hooker (F.B.I. vi, 181) has this note : 'Mr. Ridley, who finds this species [*L. paradoxa*] at Singapore, informs me that there are two forms, one with pure yellow flowers, the other with the sepals and petals deep blackish purple, and the lip green with purple centre, which latter is the *L. nervosa* Lindl. Gen. and Sp. Orchid. 24.' It is strange that Ridley does not mention *Liparis nervosa* in his Flora of the Malay Peninsula.

2. **Liparis flavo-viridis** Blatter & McCann, *sp. nov.* ; *L. paradoxa* ? Gammie in Jour. Bomb. Nat. Hist. Soc. xvi, 565.

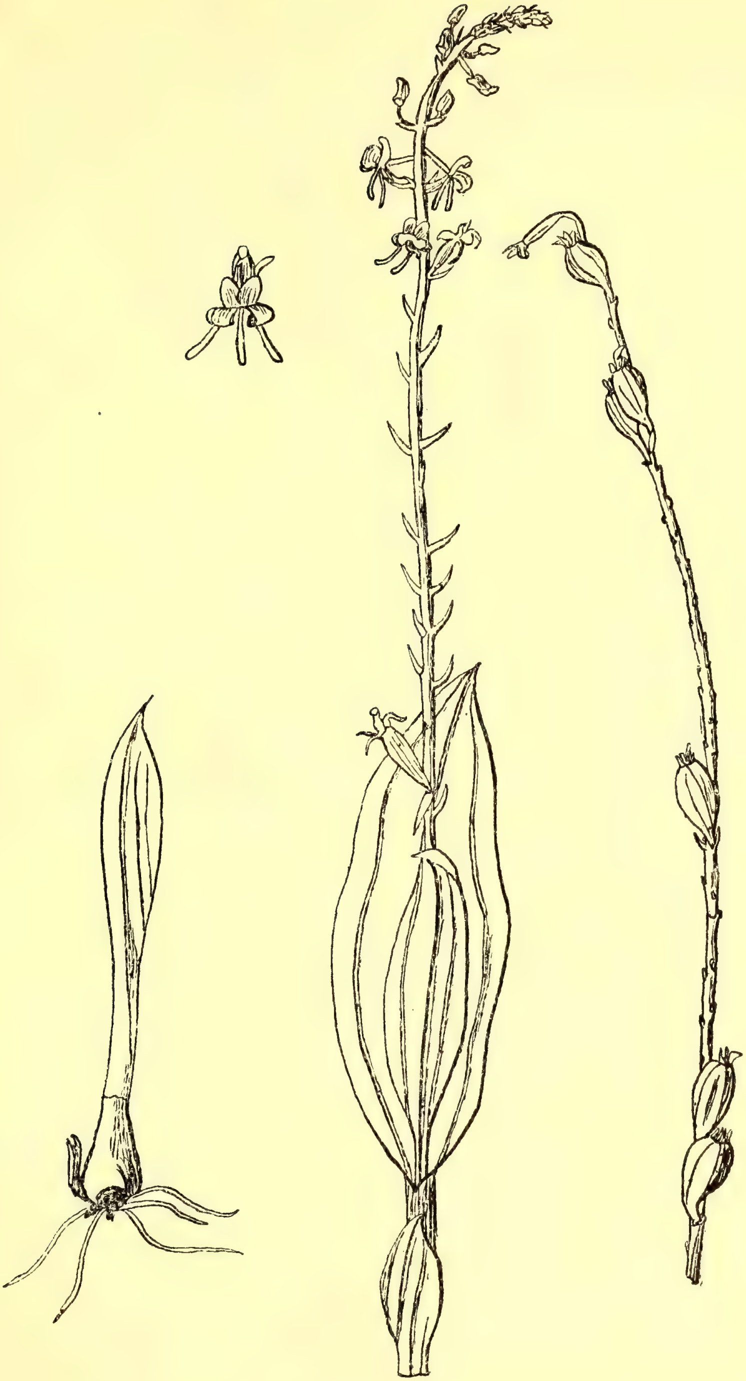
[*Orchidacea sectionis Mollifoliarum accedit ad Liparim nervosam* Lindl. *sed distinguitur foliis 5–7-nervosis, bracteis late lanceolatis acuminatis deflexis immo sub anthesi, sepalis valde inæqualibus, sepalo dorsali anguste lineari-acuminato, lateralibus obovatis convolutis apice incurvatulis, petalis convolutis sursum curvatis apparenter linearibus vel cylindricis, labio subrotundo apice minutim denticulato emarginato-apiculato, profunde concavo, fructu late oblongo, non clavato.*]

Description : Terrestrial herb. Pseudobulbs ovoid or oblong, 5–7 cm. below the surface. Stem thickened at the base and covered by several sheaths. Leaves 2–5, lying more or less flat on the ground, not erect, sessile, alternate, sheathing, up to 14 by 8 cm., ovate or elliptic-lanceolate, subacuminate or acuminate, subplicate ; main nerves 5–7, deeply depressed above, very prominent beneath. Scape together with raceme up to 20 cm. long, erect, slender, with scattered bracts. Bracts broadly lanceolate, acuminate, deflexed even at time of flowering, shorter than the somewhat twisted ovary. Buds ovate-oblong, obtuse at apex, not obliquely obovate. Scape, lateral sepals, petals and column light green, lip, anther and cap of column very dark green, floral bracts between the two in shade. Dorsal sepal up to 6 mm. long, narrow lanceolate-acuminate, generally reflexed, leaving the back of the column bare and lying along the ovary. Lateral sepals 5–6 mm. long, straight, convolute, obovate, acute, slightly incurved at apex. Petals slightly longer than the lateral sepals, strongly convolute, appearing linear or rather cylindrical, curved upwards, sticking out together with the lateral sepals under the lip, nearly touching its under-surface with their points. Base of lip in its lower third lying close against and almost parallel to the column with 2 well-developed calli at the very base, calli applied against base of column, of moderate length, conical, rounded at top, very shiny and rugose except at top ; limb large, almost orbicular 7 by 8 mm., bent at right angles to the narrowed base, minutely-toothed on the upper margin, emarginate at apex with a minute apiculus, deeply concave, the concavity widening from base of sepal forwards and very shiny along bottom for more than half-way, finely darker-veined, the veins running from the concavity towards the circumference all round, generally simple, sometimes forked. Ovary sessile with slightly winged and thin ridges. Column elongate, stout, inflexed from half-way up, dilated at base. Cap somewhat convex with the hinder lateral slopes, a little flattened before it lifts for the emission of the pollinia, fringed with a thin narrow membrane and minutely rugose laterally. Pollinia 4, without caudicles, in pairs, golden yellow, each pair closely pressed together, the 2 pollinia of each pair of different length, the outer faces convex. Fruit broadly oblong, stalked, 2 cm. by 7 mm.

In bud, the lip embraces the whole column. The pollinia fall out when the cap rises, which happens shortly after the flower opens.

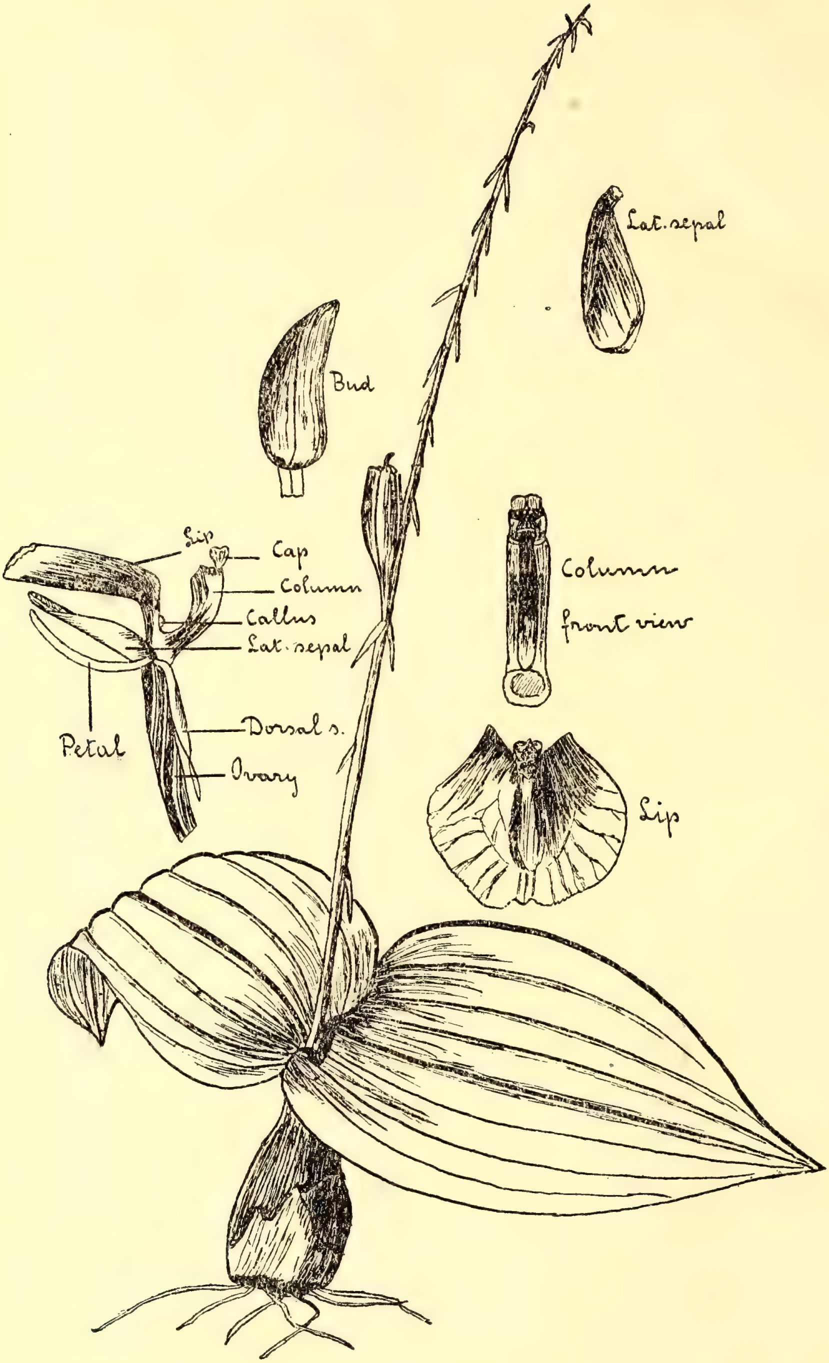
Locality : Mr. T. R. Bell found this orchid in August, 1912, in N. Kanara on the low margin of a tank off the high road from Yellapur to Karwar, on the left-hand side going out from Yellapur, just before the path goes off to Kowdekeri. It was common locally. He found it again in August, 1918, at Dandeli, N. Kanara. It is from this plant that the above description is taken (Bell no. 4217 !).—*S. M. Country :* Londa (several sheets by Spooner in Herb. Econ. Bot. Poona).

Flowers and fruit : August.



Del. C. McCann after Miss E. Bell.

Liparis nervosa, Lindl.


Lat. sepal
Bud
Lip
Cap
Column
Callus
Lat. sepal
Petal
Dorsal s.
Ovary
Column
front view
Lip

Del. C. McCann partly after Miss E. Bell.
Liparis flavo-viridis, Blatter & McCann, *sp. nov.*

4. Dendrobium Sw.

Species about 750. Tropical Asia, Japan, Australia, Polynesia.

Of the 8 species mentioned by Cooke *D. Macraei* Lindl. has to be transferred to the genus *Desmotrichum*, the name of *Dendrobium chlorops* has been changed into *D. ovatum* Kränzl. We add 2 other species not contained in Cooke: *D. aqueum* Lindl. and *D. actinomorphum* Blatter & Hallberg.

Note: The *Dendrobiums* have a definite vegetative period. During the monsoons new shoots are formed from the bases of the old ones, full of leaves. At the end of the monsoons the 'new' stems reach maturity and are full of reserve material. After the monsoon the leaves are shed leaving the naked stem. The stem thus developed at the end of one monsoon flower during the cold season, and even into the hot weather. After flowering and fruiting these stems wither away and die. No stem flowers twice. This we have found to be particularly true of Nos. 1, 2, 3, 4. It appears to us that Dendrobiums growing in evergreens sometimes flower towards the end of the monsoon as we have observed with No. 7, which we found in flower on the Fitzgerald Ghat, on the 9th October (1930). In this case the superabundant food material probably caused the plants to flower and in such a case the same stem would probably flower again. Evergreen inhabiting plants may deviate somewhat from those found in deciduous forest.

A. Pseudobulbs short, tufted, with 2 or 3 leaves; or stems elongate and leafy. Flowers in slender terminal or lateral racemes, small or medium-sized; lip often with a flat keel on the disk that ends in a truncate crenate callus on the midlobe.
  I. Stems simple or nearly so, often a small pseudobulb.
    1. Small plants with crowded ovoid pseudobulbs. Flowers small, in racemes from the top of the pseudobulb; petals not broader than the dorsal sepal. Sepals and petals white.
      (*a*) Lip pink with dark-red veins ... ... 1. *D. microbulbon.*
      (*b*) Lip yellow-green ... ... 2. *D. Mabelæ.*
    2. Larger plants; stems tufted. Flowers in terminal and lateral racemes; petals broader than the dorsal sepal.
      (*a*) Flowers cream-coloured. Lateral sepals oblong; midlobe of lip subquadrate ... 3. *D. ovatum.*
      (*b*) Flowers white, mostly with a tinge of pink. Lateral sepals lanceolate, falcate; midlobe of lip ovate, acute ... ... 4. *D. barbatulum.*
  II. Stems long, copiously branched; flowers small. 5. *D. herbaceum.*

B. Stems elongate, stout or slender, cylindric, clavate or nodose. Flowers in lateral pairs or fascicles or racemes, rarely solitary, usually large, white, yellow, purple or pink.
  I. Mentum present.
    1. Mentum half as long as the dorsal sepal; lip longer than broad (18 by 12 mm.) ... 6. *D. macrostachyum.*
    2. Mentum less than half as long as the dorsal sepal; lip as broad as long (12 by 12 mm.). 7. *D. crepidatum.*
    3. Mentum very short, rotund. Lip much longer than broad (25 by 15 mm.) ... ... 8. *D. aqueum.*
  II. Mentum absent ... ... 9. *D. actinomorphum.*

1. **Dendrobium microbulbon** A. Rich. in Ann. Sc. Nat. sér. 2, xv (1841) 19, f. 8; Lindl. in Bot. Reg. (1844) 61; Dalz. & Gibs. Bomb. Fl. 261; Hook. f. F.B.I. v, 716; Cke. ii, 681.—*D. humile* Wight Ic. (1852) t. 1643.—*D. crispum* Dalz. in Hook. Journ. Bot. iv (1852) 111.

Description : Cke. ii, 681.—Add :

Pseudobulbs one on top of the other, often the whole 2-3-pointed, each pear-shaped and, of course, constricted at the junctions, one sheath generally reaching over 2 bulbs, 16 mm. long, longitudinally ribbed, light green coloured, embracing the whole bulb at base. Leaves often purple-spotted and marked above with irregularly impressed veins, longitudinally above and simply pointed below. Flowers 16 mm. long, 12 mm. broad. Bracts straw-coloured, longitudinally veined, up to 4 mm. long. Dorsal sepal 9 by 3 mm., lateral ones up to 8 mm. long, 3 mm. broad at middle. Petals 9 mm. or less, apiculate (Cooke has obtuse). Lip 6 mm. long, 4 mm. broad, broadest at end, 6 mm. broad when spread out, often green with red veins and edges. Cap square, cordate, 0·5 mm. broad. Pollinia 0·25 mm. long (Bell MS.).

Kränzlin points out that in the lip of the live flower there are tender hyaline papillæ which disappear very soon and cannot be seen in dried specimens. When, however, the dry flower is boiled, the margin of the papillose lip appears to be what we call ' crenulate '.

Locality : Konkan : (Stocks) ; Thana forests (T. R. Bell 3842 !).—*W. Ghats :* Mahableshwar, 4,500 ft. (Cooke !, Sedgwick 7324 !, Ezekiel 26568 !, Millard 25821 !, Chibber !, Fernandez !).—*S. M. Country :* Deciduous forests S.-W. of Dharwar, 1,800 ft., rainfall 40 in. (Sedgwick 3788 !) ; Amboli Ghats (Bell !). —*N. Kanara :* (T. R. Bell 4359 !).

Distribution : Nilgiris, Anamalais.

Flowers : January 1929 (Amboli Ghat) ; February 1918 (Thana) ; March 1917, 1918 and 1920 (Mahableshwar) ; April 1918 (Mahableshwar) ; September 1918 (N. Kanara) ; December 1918 (Dharwar).

2. **Dendrobium Mabelæ** Gammie in *Journ. Bomb. Nat. Hist. Soc.* xvi (1905) 567 ; Cke. ii, 681 ; Kränzl. in Engl. Pflanzenr. iv, 50, ii, B 21 (1910) 80.

Description : Cke. l.c.—Add : Whole flower dead white except extremity of column outside with a green tip. Column like that of *D. microbulbon*, but stigma comparatively longer. Front of cap quite straight and long (Bell MS.).

Locality : W. Ghats : Foot of Fitzgerald Ghat (Fernandez !) ; Castle Rock, on *Phyllanthus emblica*, 1,600 ft., rainfall 250 in. (Sedgwick 2855 !, 5541 !) ; Castle Rock (Bhiva !, Gammie 15782 !) ; Londa (Bhiva !) ; Belgaum Ghats (Gammie !) ; Panchgani (McCann !).—*N. Kanara :* Anmod, on the smaller branches of trees (Sedgwick 3370 !) ; Tinai Ghat, on small trees, especially on *Phyllanthus emblica*, 1,800 ft., rainfall 150 in. (Sedgwick 3197 !, Gammie 15802 !).

Distribution : Apparently endemic.

Flowered at Panchgani at end of September 1930.

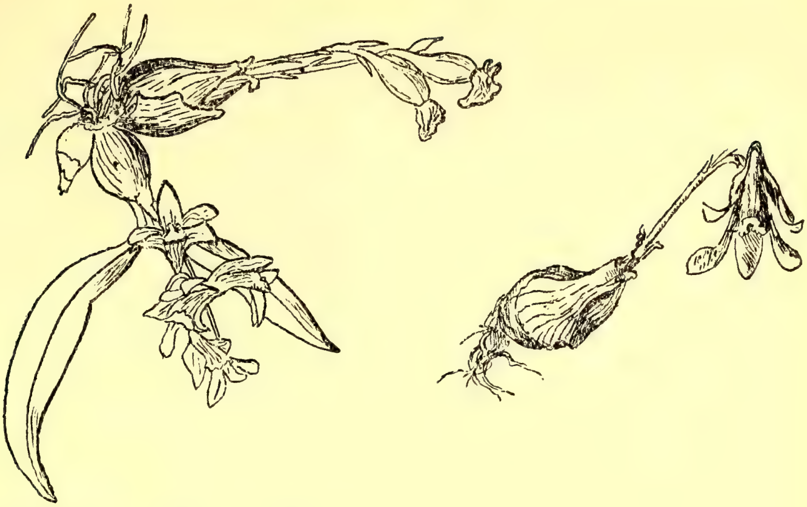
3. **Dendrobium ovatum** (Willd.) Kränzl. in Engl. Pflanzenr. iv, 50, ii, B 21 (1910) 71 ; Fischer Fl. Madras pt. viii (1928) 1416.—*D. chlorops* Lindl. in Bot. Reg. (1844) Misc. 44 ; Dalz. & Gibs. Bomb. Fl. 261 ; Veitch Man. Dendr. 27 ; Williams Orch. Grow. Man. 7th ed. 329 ; Sander Orch. Guide 68 ; Hook. f. F.B.I. v, 719 ; Cke. ii, 682.—*D. barbautulum* Wight Ic. iii (1843) t. 910.—*Cymbidium ovatum* Willd. Sp. Pl. iv, 1 (1805) 101.—Rheede Hort. Malab. xii. t. 7.

Description : Cke. ii, 682.—The flowers are very variable in size and colour. The midlobe of the lip is sometimes subacute or with a minute mucro in the same plant. The pubescent part in front of the ridge of the disk was green in Salsette specimens, the hairs at the very base of the lip on the sides of the ridge yellowish (Hallberg MS.).

Locality : Konkan : (Stocks) ; Thana forests, rainfall 150 in. (T. R. Bell 3624 !, 3647 !) ; Salsette (Hallberg !) ; Tulsi Lake, Salsette (McCann !) ; Wandra forests (Ryan 65 !) ; Sagwan (Ryan 359 !) ; Pen to Campoli, on trees (Gammie 16087 !) ; Khardi (Ryan 566 !) ; Wada range (Ryan 528 !) ; Bassein (Ryan 483 !, 896 !) ; Matheran (Birdwood) ; Thana District, on mango trees (Kirtikar).—*W. Ghats :* Khandala, rare (Blatter & Hallberg 26492 !) ; Mahableshwar (Cooke !) ; Phonda Ghat (Ritchie 1410).

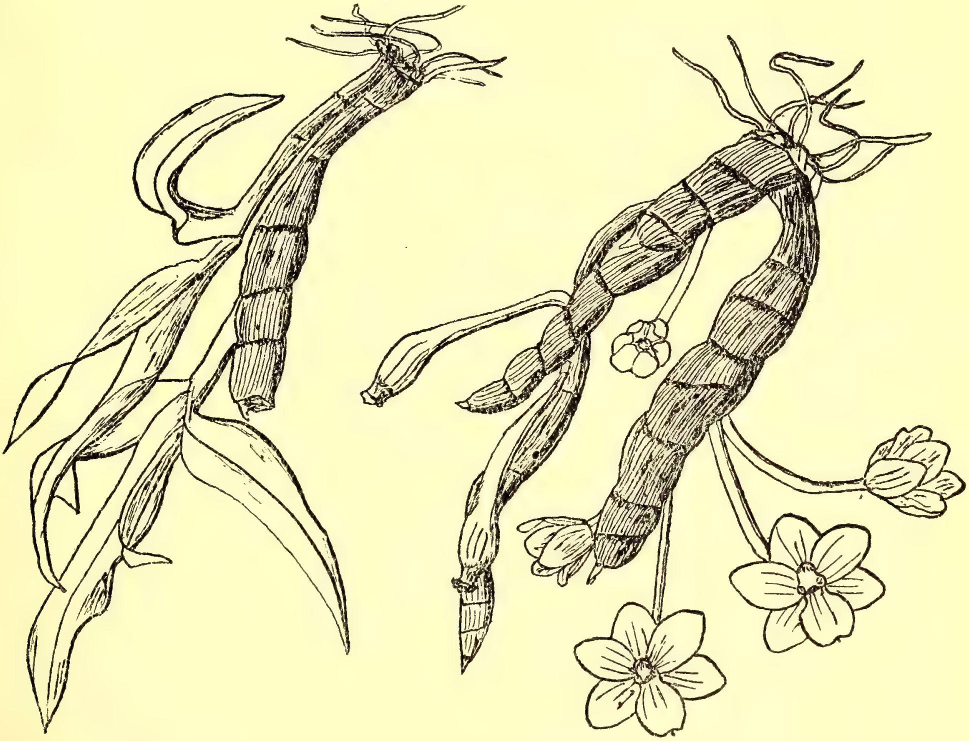
Distribution : W. Ghats and the W. coast of Madras Presidency from 150-5,000 ft.

4. **Dendrobium barbatulum** Lindl. in Wall. Cat. (1828) no. 2013, Gen. & Sp. Orch. (1830) 84 ; Paxt. Fl. Gard. iii, 113, fig. 285 ; Bot. Mag. t. 5918 (*non*



Del. C. McCann after Miss E. Bell.

Dendrobium microbulbon, A. Rich.



Del. C. McCann partly after Miss E. Bell.

Dendrobium crepidatum, Lindl.

5444) ; Hook. f. F.B.I. v, 719 ; Veitch Man. Dendr. 21 ; Williams Orch. Grow. Man. 7th ed., 326 ; Cogn. Dict. Icon. Orch. Dendrob. t. 25 ; Cke. ii, 682 ; Fischer Fl. Madras pt. viii (1928) 1416 ; Kränzl. in Engl. Pflanzenr. iv, 50, ii, B 21 (1910) 70.

Description : Cke. ii, 682.—Notes : Cooke says that the midlobe is bearded at the base with yellow hairs. It would be more accurate to say that the midlobe is bearded in front of the channelled ridge and at the base of lip on the sides of the ridge (Hallberg MS.).

Locality : Khandesh (Hallberg !).—*Konkan :* (Stocks, Law) ; Thana forests, rainfall 150 in. (T. R. Bell 3637 bis !) ; Thana (Kirtikar) ; Kanari Caves (McCann !) ; Dapoli, Ratnagiri District (Kirtikar) ; Ratnagiri (Kirtikar).—*W. Ghats :* Khandala (Hallberg 26539 !, Blatter 26540 !, Blatter & Hallberg 26537 ! ; McCann !) ; Kune, near Khandala (Blatter & McCann 26491 !) ; Lonavla (McCann !) ; Sakarpatar (McCann !) ; Duke's Nose (McCann !) ; Tiger's Leap (McCann !) ; near Campoli (McCann !) ; Pen (McCann !) ; Kasara (McCann !) ; Igatpuri (McCann 26538 !) ; Panchgani (Fernandez !) ; Bilar, 4 miles S.-W. of Panchgani (McCann !) ; on road from Panchgani to Mahableshwar (Blatter & Hallberg B 1682 !) ; Mahableshwar, common (Cooke !, Ezekiel 26567 !, 26569 !).—*N. Kanara :* Tinai Ghat, 2,000 ft., rainfall 200 in. (Sedgwick 3616 !).

Flowers from January to March. McCann has seen flowers of this species as late as the 29th May (1931) at Khandala.

Distribution : W. Ghats from Mysore to Travancore.

5. **Dendrobium herbaceum** Lindl. in Bot. Reg. (1840) Misc. 69 ; Hook. f. F.B.I. v, 719 ; Cke. ii, 682 ; Gammie in Journ. Bom. Nat. Hist. Soc. xvii, 32 ; Kränzl. in Engl. Pflanzenr. iv, 50, ii, B 21 (1910) 72 ; Fischer Fl. Madras pt. viii (1928) 1416.—*D. ramosissimum* Wight Ic. t. 1648 ; Dalz. & Gibs. Bomb. Fl. 261.

Description : Cke. ii, 682.

Locality : Konkan (Dalzell, Gibson).—*W. Ghats :* Mahableshwar (Woodrow !, Acland !) ; Koina Valley, below Mahableshwar (Cooke !) ; Wada, below Mahableshwar (Cooke !).—*N. Kanara :* Anmod, 2,000 ft., rainfall 200 in. (Sedgwick 3437 !).

Distribution : W. Ghats of Madras Pres., from 2,000-4,000 ft., Godavari District, Parasnath, Bengal.

Flowers : October 1924 (Mahableshwar).

Fruit : December 1917 (N. Kanara).

6. **Dendrobium macrostachyum** Lindl. Gen. & Sp. Orchid. (1830) 78 *et* Bot. Reg. t. 1865 ; Wight Ic. t. 1647 ; Hook. f. F.B.I. v, 735 ; Cke. ii, 683 ; Kränzl. in Engl. Pflanzenr. iv, 50, ii, B 21 (1910) 59 ; Sander Orch. Guide 72 ; Fischer Fl. Madras pt. viii (1928) 1416.

Description : Cke. ii, 683.—Midlobe of lip embraces the whole column (Bell MS.).

Locality : S. Konkan (Dalzell 45 !).—*W. Ghats :* Koina Valley below Mahableshwar (Cooke !) ; Belgaum Ghats (Gammie).—*N. Kanara :* Forests (Herb. Econ. Bot. Poona) ; Yellapur, 2,000 ft., common (Sedgwick 2469 !, T. R. Bell 6067 !).

Distribution : W. coast and W. Ghats of Madras Pres. up to 7,000 ft., Travancore, Ceylon, Maldives, Central Provinces, frequent, Chota Nagpur, very doubtfully in Burma.

7. **Dendrobium crepidatum** Lindl. in Paxt. Fl. Gard. i (1850-51) 63 ; *nov ed.* i (1882) 53, fig. 40 ; Bot. Mag. t. 4993 *et* t. 5011 ; Veitch Man. Dendr. 33 ; Hook. f. F.B.I. v, 740 ; Grant Orch. Burmah 78 ; King & Pantl. in Ann. Bot. Gard. Calc. viii, 48, t. 66 ; Dict. Icon. Orch. Dendrob. t. 40 ; Cke. ii, 683 ; Kränzl. in Engl. Pflanzenr. iv, 50, ii, B 21 (1910) 39.—*D. lawanum* Lindl. in Journ. Linn. Soc. iii (1859) 10 ; Dalz. & Gibs. Bom. Fl. 261 ; Kränzl. l. c. 297.—*D. roseum* Dalz. in Hook Kew Journ. (1852) 291.

Kränzlin l. c. 39 considers *D. lawanum* Lindl. and *D. roseum* Dalz. as synonyms of *D. crepidatum* and has also included Law's specimen (Low by mistake) collected in the Konkan.

We don't quite see why the same author (l. c. 297) mentions *D. lawanum* as a distinct species under the heading ' *Dendrobia adhuc solummodo in statu* *pelorioideo nota.*' He also adduces *D. roseum* Dalz. as a synonym and mentions the same specimen gathered by Law in the Konkan. Owing to an oversight, another mistake crept in in this place : The Konkan is put down as belonging to the botanical province of the tropical Himalaya.

Locality : Konkan (Law, Stocks) ; near Vengurla (Dalzell 33).—*W. Ghats :* Mahableshwar Hills (Cooke !) ; Lonavla (Gammie 16241 !) ; Koina Valley below Mahableshwar (Cooke !) ; Belgaum Ghats (Gammie !).—*N. Kanara :* Anmod, 2,000 ft., rainfall 200 in. (Sedgwick 3319 !) ; Tinai Ghat (Gammie 15814 !).

Distribution : Chota Nagpur, Sikkim, Assam, Khasia Hills, Upper Burma (Kränzlin mentions Malabar, but according to Fischer, Fl. Madras, this species has not been found in the area of his Flora).

8. **Dendrobium aqueum** Lindl. in Bot. Reg. (1843) Misc. 6, t. 54 ; Bot. Mag. t. 4640 ; Veitch Man. Dendr. 18 ; Sander Orch. Guide 67 ; Hook. f. F.B.I. v, 739 ; Kränzl. in Engl. Pflanzenr. iv, 50, ii, B 21 (1910) 52.—*D. album* Wight Ic. Pl. (1852) t. 1645 ; Williams Orch. Grow. Man. 7th ed. 324 ; Orch. Album t. 407.

Description : Stems fasciculate, decumbent, thickened from a thin base and slightly compressed, with many or several articulations, leafy, 30–45 cm. long, in the middle almost 1 cm. diam. Leaves ovate-lanceolate, acuminate ; the sheaths widened above ; lamina well-articulated, 8–12 cm. by 2–3 cm., striate, persistent during the flowering time. Racemes short, usually 2-flowered, rarely 3-flowered. Bracts very minute. Flowers white, suffused with green, lip suffused with pale yellow inside. Sepals and petals 3 cm. long, 1·5–1·8 cm. broad. Sepals ovate, lateral ones ovate-triangular, subfalcate ; mentum very short, rotund. Petals obovate, equal in size, all acute. Lip 2·5 by 1·5 cm., subrhomboid, ascending from the base to the middle, then deflexed, acute in front, obscurely 3-lobed, rotund on both sides, in the middle of the disk slightly excavate, triangular in front, the whole disk puberulous, the margin of the midlobe denticulate-ciliate, a raised line from the base of the disk to almost the middle. Ovary with pedicel 2·5 cm. long.

Locality : Konkan (Stocks ex Kränzlin).—Sometimes grown in gardens of the Bombay Pres.

Distribution : W. Ghats of the Madras Pres. 3,000–7,000 ft.

9. **Dendrobium actinomorphum** Blatter & Hallberg in Journ. Ind. Bot. ii (1921) 50, Fig. 4.

Description : A pendulous epiphyte with numerous very slender matted roots. Flowering stem reaching 25 cm., leafless, jointed, internodes thick, cylindrical, about 2 cm. long, slightly thickened below the nodes, fleshy, green, each internode completely enclosed in a scarious many-nerved sheath arising at the node and extending to about the middle of the next internode, tip of sheath 1 cm. broad, deeply emarginate, nerves parallel, 9 prominent ones alternating with 10 less conspicuous ones, prominent ones very stout and white. Last internode very short and conical. Leafy shoots appearing after the flowering at the base of the flowering stem. Leaves distichous ; lamina of young leaves about 10 cm. long, with 5 conspicuous and many inconspicuous nerves ; petiole amplexicaul, many-nerved. Flowers in pairs or solitary arising from the nodes. Pedicels stout, 2·5–3·5 cm. long, pinkish in flower, clavate and green in fruit. Flowers subregular, 3 cm. across, shallowly cup-shaped ; sepals and petals subequal in length, pinkish, sepals 15 mm. long, about 7–8 mm. broad, oblong, subobtuse or mucronate. Petals and lip broadly ovate-oblong, 15–17 mm. long, 10 mm. broad, rounded or retuse at tip. Column very short, white, with 2 dark purple processes at the base, behind each of which there is a deep cavity (probably nectary). Anther terminal, flat on top, 2–celled. Pollinia 4, 2 in each cell, waxy, yellow, free in the cells, without caudicle or viscid appendage. Capsule about 2 cm. long, 1 cm. thick, pear-shaped, crowned by a cylindrical clavate process formed by the hardened column slightly trigonous.

Can be distinguished by the absence of the mentum. Otherwise agreeing in many points with *D. crepidatum* Lindl.

Locality : *N. Kanara* : Castle Rock (McCann 13768 !).

Distribution : Apparently endemic.

Flowers : March 1919.

5. DESMOTRICHUM Blume (*emend. a* Kränzlin).

Epiphytic herbs. Stems long-pendulous, clothed with imbricating cataphylls, radical, branching. Branches often thickened into fusiform or subcylindrical bulbs which bear usually 1 leaf, rarely 2. Flowers fascicled, arising from the axil of the leaf, fugaceous. Bracts scarious, always much shorter than the thin pedicels, forming a capitulum. Dorsal sepal and smaller petals attached to the back and sides of the column ; lateral sepals adnate to the foot of the column and forming with it a small mentum (spur) which is more or less closed in front. Basal part of lip always narrow, rather elongate, prolonged in front into small lateral lobes ; midlobe flabellate or dilate, with the margin more or less pinnatifid or sinuate, always undulate or fimbriate or pilose, the 2 lines near the margin of the disk more or less undulate. Column as in *Dendrobium.*

Species about 30.—Indo-Malayan.

The only species observed in the Presidency was usually known as *Dendrobium macraei* Lindl.

1. **Desmotrichum fimbriatum** Blume Bijdr. (1825) 329 ; Kränzl. in Engl. Pflanzenr. iv, 50, ii, B 21 (1910) 354 ; Fischer Fl. Madras pt. viii (1928) 1412.—*Dendrobium fimbriatum* Lindl. Gen. & Sp. Orchid. (183) 76. (*nec* Hook. *nec* Dalzell *nec* Wallich).—*D. Macraei* Lindl. l. c. 75 ; Dalz. & Gibs. Bomb. Fl. 260 ; Hook. f. F.B.I. v, 714 ; Grant Orch. Burmah 104 ; King and Prantl. in Ann. Bot. Gard. Calc. viii, 61, t. 86 ; Cke. ii, 680 ; Gammie in Journ. Bomb. Nat. Hist. Soc. xvi (1905) 566.—*D. plicatile* Lindl. Bot. Reg. (1840) Misc. 10.—*D. insulare* Steud. Nomencl. ed. 2, i (1841) 490.—*D. nodosum* Dalzell in Hook. Kew Journ. Bot. iv (1852) 292.—*D. flabellum* Reichb. f. in Bonpl. v (1857) 56 *et* Xen. Orch. ii, 75, t. 118, fig. 7.—*D. Binnendijkii* Reichb. f. Xen. Orch. ii (1865) 74, t. 118, fig. 6.—*D. Rabani* Lindl. in Journ. Linn. Soc. iii (1859) 7.—*D. pardalinum* Reichb. f. in Gard. Chron. ii (1885) 230.—*D. rhipidilobum* Schlecht. in Schum. & Lauterb. Nachtr. Fl. Deutsch. Schutzgeb. (1905) 151.—*D. Kunstleri* Hook. f. F.B.I. v, 714.

Description : Cke. ii, 680.

Locality : See Cke. l. c. 681.

Distribution : W. Ghats of Bombay and Madras Presidencies, Ceylon, Sikkim, Khasia Hills, Burma, Malay Peninsula and Archipelago to the Philippines.

6. BULBOPHYLLUM Thouars. (Emend.).

Hook. f. (in F.B.I. v, 772) says : 'The species of *Bulbophyllum* and *Cirrhopetalum* are in many cases so allied by cross affinities that the two genera might be regarded as one. My keeping them apart is due to the consideration of convenience, and the fact that all my attempts to commingle the species of both have resulted in a chaotic aggregate, with most unsatisfactory sectional characters.'

J. J. Smith in a paper entitled : *Bulbophyllum* Thou. sect. *Cirrhopetalum* [Bull. Jard. Bot. Buitenz. sér. 2, vii (October 1912) 19–29] has tried to neglect the view of Hooker's 'convenience' and to overcome his practical difficulties by transferring the species of *Cirrhopetalum* to the genus *Bulbophyllum.* We follow him.

The diagnosis of the genus *Bulbophyllum* must include those characteristics by which *Cirrhopetalum* was distinguished before by Lindley and Hook. f., viz. by the more often and regularly whorled flowers and by the short dorsal sepal, rarely half the length of the almost invariably much longer lateral, and finally by the very small stipitate lip.

Species about 550.—Tropical and subtropical.

1. Sepals green. Flowers in umbels ... 1. *B. fimbriatum.*
2. Sepals dull brownish yellow. Flowers in racemes ... ... 2. *B. neilgherrense.*

1. **Bulbophyllum fimbriatum** Reichb. f. in Walp. Ann. vi, 260.—*Cirrhopetalum fimbriatum* Lindl. in Bot. Reg. (1839) Misc. 72 ; Bot. Mag. t. 4391 ; Wight Ic. 1655 ; Gammie in Journ. Bomb. Nat. Hist. Soc. xvii (1906) 34 ; Cke. ii, 686 ; Fischer Fl. Madras pt. viii (1928) 1420.—*C. Wallichii* Grah. Cat. 205 (*non* Lindley).

Description : Cke. ii, 686 (under *Cirrhopetalum fimbriatum*).

Locality : Cke. l.c.—Add : *W. Ghats :* Mahableshwar (James in Herb. Calc. !, Hallberg !) ; Tinai Ghat (Bhide !).—*N. Kanara :* Very common at Astoli and towards Chandwadi, in flower and leafless at the end of March 1911 (Bell !).

Distribution : Bombay Pres.: Konkan, Deccan, S. M. Country, W. Ghats, N. Kanara ; Coorg.

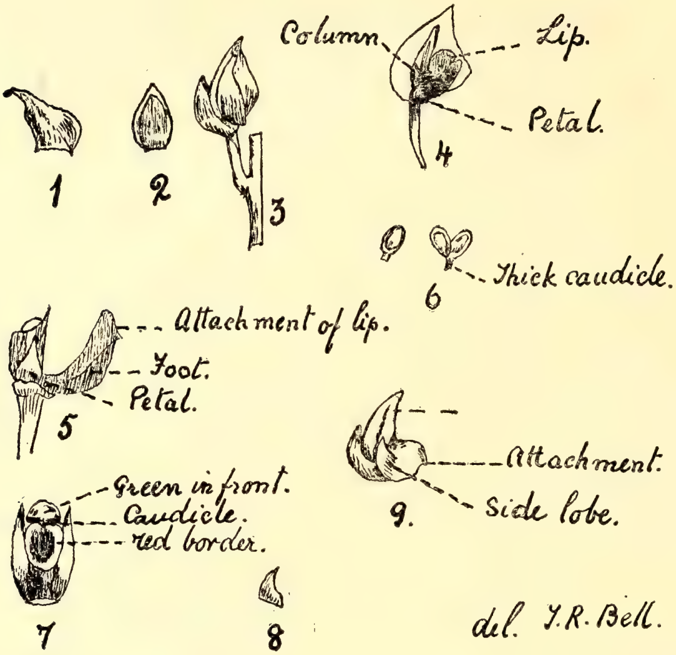


FIG. 1. *Bulbophyllum neilgherrense*, Wight.

1. Lateral sepal.
2. Dorsal sepal.
3. Bud.
4. Column and lip.
5. Column (side view).
6. Pollinia.
7. Column (front view).
8. Petal.
9. Lip.

2. **Bulbophyllum neilgherrense** Wight Ic. v (1852) 6, t. 1650 ; Bot. Mag. t. 5050 ; Gamie in Journ. Bomb. Nat. Hist. Soc. xvii (1906) 33 ; Cke ii, 686 ; Fischer Fl. Madras pt. viii (1928) 1418.

Description : Cke. ii, 686.—The pollinia are in pairs, one of each pair smaller than the other, applied closely along the inner faces, the outer faces convex ; caudicle short, oblong, black. There are bulbs of all sizes bearing a single erect spike of flowers, densely packed, the larger bulbs bear larger spikes. Spikes catkin-shaped, flowering from below upwards. The flowers smell of highly rotten meat, and are chrome-yellow. Column white, the stigmatic hollow bordered thinly red, the foot also bordered red from stigma to end ; lip with side lobes bordered blackish ; cap yellow, greenish in front ; pollinia pure bright yellow (Bell MS.).

Locality : W. Ghats : Belgaum Ghats (Gammie !).—*N Kanara :* Ghats (Gammie !) ; Sampkhand (Woodrow) ; Yellapur, 2,000 ft., rainfall 100 in, (Sedgwick 2532 !) ; Kumbarwada (Bell !).

Distribution : W. Ghats of Madras Pres,

7. TRIAS, Lindl.

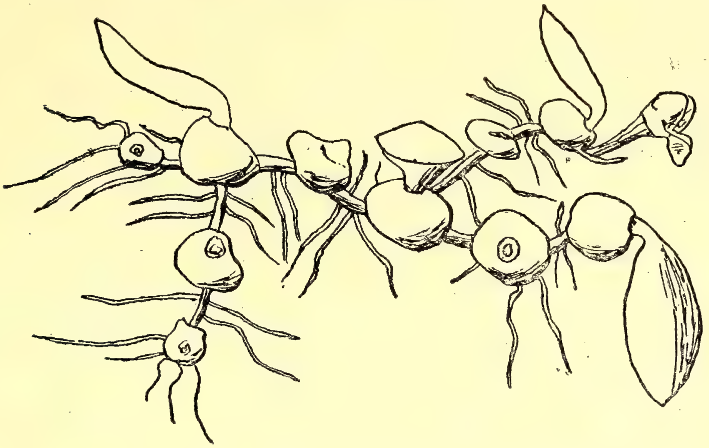


FIG. 2. *Trias Stocksii*, Hook. f.

Species 3.—Indo-Malayan.

1. **Trias stocksii** Hook. f. F.B.I. v (1890) 781 ; Gammie in *Journ. Bomb. Nat. His. Soc.* xvii (1906) 34 ; Cke. ii, 687.

Description : Cke. ii, 687.

Locality : Konkan (Law).—*N. Kanara :* (Stocks 69) ; Chandawadi (Bell !) ; Pavhol (Bell !).

8. PHOLIDOTA, Lindl.

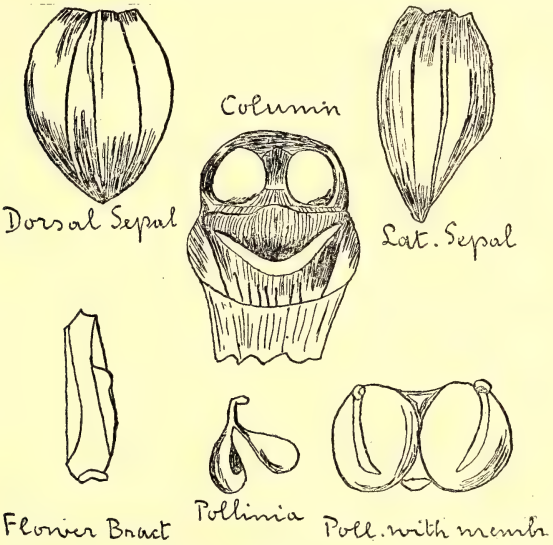

Column
Dorsal Sepal
Lat. Sepal
Flower Bract
Pollinia
Poll. with memb.

FIG. 3. *Pholidota imbricata*, Lindl.

Species 30.—Indo-Malayan, China.

1. **Pholidota imbricata** Lindl. in Hook. Fl. Exot. (1825) t. 138 ; Dalz. & Gibs. 262 ; Wight Ic. t. 907 ; Lindl. Bot. Reg. t. 1213 *et* t. 1777 ; King &

Pantl. in Ann. Roy. Bot. Gard. Calc. viii, 144, t. 201; Cke. ii, 688.—*Ptilocnema inbricatum* Don Prodr. 33.—*Cymbidium imbricatum* Roxb. Fl. Ind. iii (1832) 460.

Description : Cke ii, 688.

Locality : Konkan : (Stocks); S. Konkan (Dalzell 51); near Vengurla (Dalzell & Gibson.).—*N. Kanara :* Sampkhand, 1,600 ft., rainfall 200 in. (Herb. S.X.C. 26516 !, Sedgwick & Bell 6963 !).

Distribution : Nepal, Chota Nagpur, Konkan, N. Kanara, W. and E. Ghats of Madras Pres., 2,000–3,500 ft., Ceylon, Malay Peninsula, China, Malay Archipelago to the Philippines, Pacific Islands.

Flowers : July 1895 (N. Kanara).

Fruit : October 1919 (N. Kanara).

9. JOSEPHIA, Wight.

Species 2.—India, Ceylon.

1. **Josephia lanceolata** Wight Ic. v (1852) 19, t. 1742 (*folia tantum*), *flores in* t. 1743; Hook. f. F.B.I. v, 823; Cke. ii, 688; Fischer in Fl. Madras pt. viii (1928) 1428.

Description : Cke. ii, 688.—Sepals white tinged with yellow. Petals and lip white. Anthers opercular, yellow with a brown spot on connective. Stigmatic lobes just in front of tip of anther (Hallberg).

Locality : N. Kanara (Stocks ! in Herb. Calc.).—Has never been gathered in the Pres. since Stock's time.

Distribution : W. Ghats of Madras Pres., High Wavy Mountains.

10. PORPAX, Lindl.

Species 6 —Indo-Malayan.

Cooke mentions 2 species, we add a new one. Cooke's *P. lichenora* has to be changed into *P. jerdoniana* Reichb.

I. Flowers dark purple or dull red-brown.
  1. Lip panduriform, crenulate ... 1. *P. reticulata.*
  2. Lip ligulate ... ... 2. *P. papillosa*
II. Flowers yellow ... ... 3. *P. jerdoniana.*

1. **Porpax reticulata** Lindl. in Bot. Reg. xxxi (1845) Misc. 62; Cke. ii, 689; Kränzl. in Engl. Pflanzenr. iv, 50, ii, B 21 (1911) 165.—*Eria reticulata* Benth. in Benth. and Hook. f. Gen. Pl. iii (1883) 509; Hook. f. F.B.I. v (1890) 786.—*Cryptochilus reticulatus* Reichb. f. in Bot. Ztg. (1862) 214.—*Aggeianthus marchantioides* Wight Ic. v (1852) 18, t. 1737 (*Kränzl. habet A. reticulatum per errorem*).

Description : Cke. ii, 689.—Bell & Sedgwick's specimen no. 6820 shows spathulate leaves.—Fruit globose, long-stalked, short-beaked, glabrous, about 6 mm. long, stalk almost as long, as the fruit, dorsal ridges of carpels prominent.

Locality : N. Kanara : Chandwar (Ritchie 1415); on rocks on the summit of Guddehalli Hill, 1,800 ft, rainfall 250 in. (Bell & Sedgwick 6820 !); without locality, 1,800 ft., rainfall 100 in. (Bell 5979 !); Khumbawada, 1,500 ft., rainfall 150 in. (Bell 6040 !); Sirsi, 1,600 ft., rainfall 100 in. (Bell & Sedgwick 7002 !).—Cooke says throughout the W. Ghats.

Distribution : N. Kanara, Madras Pres : Iyamalai Hills; Donipoya in S. Malabar at 700 ft.

Flowers : May, June and October 1919 (*N. Kanara*).

2. **Porpax papillosa** Blatter & McCann, *sp. nov.*

[*Accedit ad P. reticulatam* Lindl, *sed distinguitur foliis et sepalis minutim papillosis, bracteis minoribus, petalis falcatis 3-nervosis, labello ligulato, non panduriformi vel late ovato crenulato.*]

Description : Pseudobulbs button-like, 1·8 cm. diam. Sheaths membranous, margin crisped, papillose. Leaves at time of flowering 2, shorter than bract, minutely papillose on both surfaces, conspicuously so on margin. Bract membranous, orbicular, retuse, apiculate. Flowers dull red-brown, brighter inside. Sepals united into a 3-lobed tube, densely minutely papillose with papillæ in rows, 7-nerved, the outermost nerves from 2 adjoining sepals connivent downwards a little below the sinus. Petals 3-nerved, falcate-spathulate.

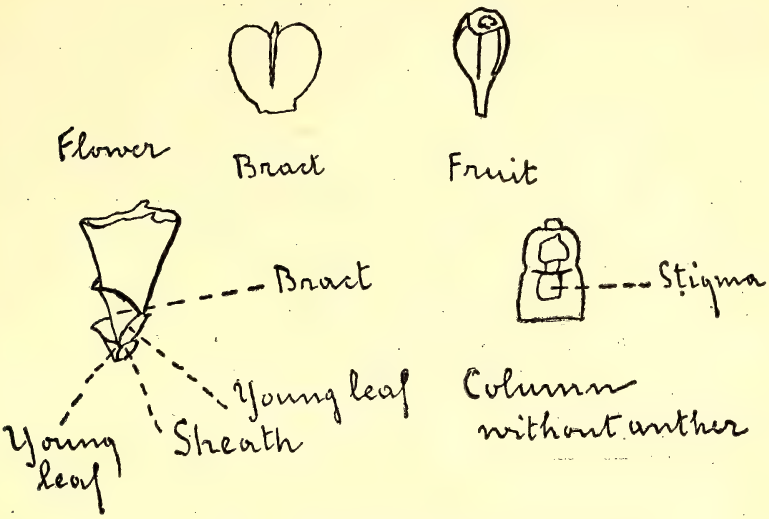

Flower
Bract
Fruit
Bract
Stigma
Young leaf
Column without anther
Young leaf
Sheath

FIG. 4. *Porpax papillosa*, Blatter & McCann, sp. nov.

reaching the sinus in the calyx. Lip tongue-shaped, slightly papillose along margin, basal process prominent, elongate, narrowly triangular. Pollinia 8, anterior large, broad, pear-shaped, posterior smaller, narrow. Column with 2 ridges along the back, stronger at the top. Stigma forming a deep depression.

Locality : Prof. Hallberg found this species at Khandala in the W. Ghats in June 1917.

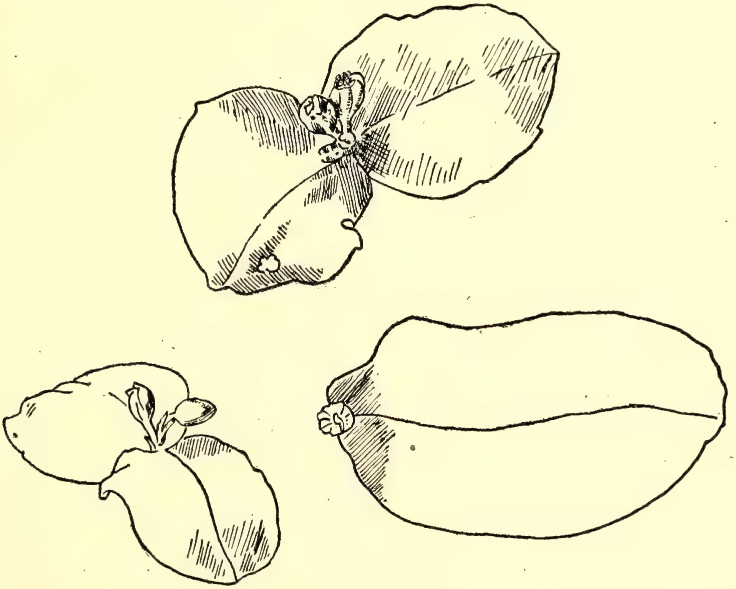


FIG. 5. *Porpax Jerdoniana*, Reichb.

3. **Porpax Jerdoniana** (Wight) Reichb. f. in Walp. Ann. vi (1861) 267; Kränzl. in Engl. Pflanzenr. iv, 50, B 21 (1911) 163.—*Eria lichenora* Lindl.,

in Journ. Linn. Soc. iii (1859) 46; Hook. f. F.B.I. v, 787; Cke. ii, 689.—*Lichenora jerdoniana* Wight Ic. v (1852) t. 1738.

Description: Cke. ii, 689.—Cooke is doubtful whether the dorsal sepal is free or connate with the lateral ones. Wight in his description says that the sepals are adherent at the base, though this fact is not shown in his drawing. Kränzlin says in his key: '*Sepalum dorsale liberum, cum lateralibus in unum biapiculatum cônnatis basi tantum coalitum.*'

Locality: Konkan: (Stocks, Law).—*W. Ghats*: Belgaum Ghats (Spooner!).—*N. Kanara:* Sampkhand (Herb. S. X. C. 26489!); Kadra, on trees, rainfall 200 in. (T. R. Bell 4285!); Anshi, 1,500 ft., rainfall 300 in. (T. R. Bell 6606!).

Distribution: W. Ghats of Bombay Pres. to Malabar and Travancore, Bababudan Hills.

11. ERIA Lindl.

Species about 330. Tropical Asia.

Cooke has 4 species: *E. reticosa, E. Dalzelli, E. microchilos* and *E. mysorensis*. We retain these, but *E. mysorensis* is being called *E. polystachya.* To these we add 2 species new to the Presidency: *E. exilis* and *E. pubescens,* and describe 2 new species: *E. rupestris* and *E. minima.*

A. Flowers solitary on slender scapes
I. Mentum bilobed ... ... 1. *E. rupestris.*
II. Mentum not lobed ... ... 2. *E. reticosa.*
B. Flowers in racemes
I. Small plants less than 10 cm. high. Leaves less than 7·5 cm. long. Scapes slender.
1. Flowers secund.
(*a*) Margin of sepals entire. Lip ovate-lanceolate ... ... 3. *E. Dalzellii.*
(*b*) Margin of sepals ciliate with minute gland-tipped hairs. Lip panduriform ... 4. *E. microchilos.*
2. Flowers not secund.
(*a*) Scape bracteate ... ... 5. *E. minima.*
(*b*) Scape not bracteate ... ... 6. *E. exilis.*
II. Larger plants exceeding 10 cm. high. Leaves 10–20 cm. long. Scapes comparatively stout. ...
1. Flowers 6–8 mm. long. Lip. entire, ovate-subpanduriform, subacute ... ... 7. *E. polystachya.*
2. Flowers 12–18 mm. long. Lip ovate-subcordate, acute ... ... 8. *E. pubescens.*

1. **Eria rupestris** Blatter & McCann, *sp. nov.*

[*Pertinet ad sectionem Conchidii. Persimilis Ericæ reticosæ Wight, distinguitur tamen bracteis mucronatis, mento bilobo, sepalo dorsali late oblongo non lanceolato, forma labelli lobo medio rotundato crenulato, fructu oblongo vel paulum obconico.*]

Description: Frequently found growing on perpendicular sides of rocks. Pseudobulbs disk-like, depressed, rounded or oblong, up to 2 cm. diam., covered with a fibrous net-work, one peduncle arising from the underside of the old pseudobulb. Leaves 2, contemporaneous with the flowers, when young ovate-acute or broadly oblong, mucronate, narrowed into a petiole 2 mm. long, the larger 3 cm. long, 12 mm. broad, dark green tinged with brown-purple, thin-fleshy, midrib depressed above, prominent below, margin densely beset with macroscopic crystalline hairs; smaller leaf up to 2·5 cm. long, up to 8 mm. broad, otherwise like the larger one; old leaves (at time of fruiting) 7 by 2·2 cm. Bud boat-shaped, green at the lower end, dirty purplish in the upper part. Flowers solitary, comparatively large, reaching 25 mm., arising from between the leaves with sheaths. Sheaths cylindric, up to 13 mm. long, lower part green, upper dingy purple, mouth oblique. Scape 1-flowered, purplish, curved by the weight of the flower, 1 mm. diam., up to 3·5 cm. long, thickened just below the flower. Bract immediately below the flower, membranous, almost orbicular, cordate, amplexicaul, pale brown-purple, mucronate at tip, with a dark midrib and 2 nerves. Sepals white or slightly suffused with pink;

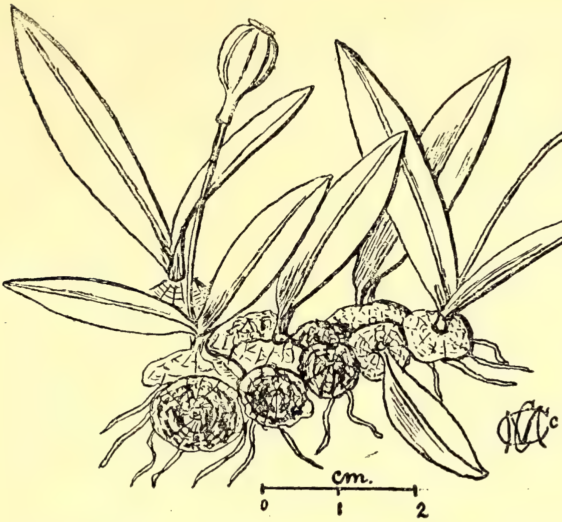


FIG. 6. *Eria rupestris*, Blatter and McCann, sp. nov.

lateral ones elongate-triangular, falcate, mucronate, 2 cm. long, strongly 7-nerved above, obscurely so below, adnate to the long-produced foot of the column; dorsal sepal broadly oblong with the apex rounded or acute, more distinctly mucronate than the lateral ones, 2·2 cm. long. Mentum 4 mm. broad, bilobed. Petals broadly lanceolate, mucronate, obscurely 5-nerved, pure white, free, 18 mm. long, 6 mm. broad. Lip oblong-obovate, sessile on the foot of the column and incumbent, 19 mm. long, 9 mm. broad in the middle, white, 3-lobed; midlobe 8 mm. long, 4 mm. broad, oblong, rounded and crenulate at tip; lateral lobes short, narrow, resembling small ears, acute at apex, 2 pale yellow crests running from the base of the lip to a little beyond the lateral lobes, the tips of the lateral lobes and the area between them golden-yellow, the edge of the lip below the yellow area purple. Column short, at the top a small white hood, foot 10 mm. long, 3 mm. broad, edge purple, on the face many parallel purple lines which get fainter towards the end of the foot. Pollinia 8, obovoid, attached by fours to a short granular membrane. Fruiting scape up to 3·5 cm. long. Fruit oblong or slightly obconical, 6-lobed with 6 strong ridges, sometimes 3 alternate ridges weaker, up to 12 mm. long, 8 mm. diam. where broadest, truncate at apex.

This species is nearly allied to *E. reticosa* Wight, from which it can easily be distinguished by the bilobed mentum and by the shape of the lip.

As to the bilobed mentum, we take it for granted that Kränzlin's statement on this point is correct. He distinguishes, e.g. his *E. braccata* from *E. extinctoria* by the large obtuse mentum, whilst *E. extinctoria* has a long obtuse bipartite mentum. The fact that the new species has a bilobed mentum would be sufficient to mark it off as a species distinct from *E. reticosa.*

Regarding the shape of the lip, Wight describes the one of his *E. reticosa* as 'obscurely 3-lobed' and 'yellow'. Hooker f. (F.B.I. v, 787) says: 'lip nearly as long as the sepals linear-oblong 3-lobed, side-lobes rounded terminal ovate, disk with 2 crested ridges.' This description agrees fairly well with Wight's Ic. 1637, which by the way, does not quite explain Wight's description. Cooke, finally, gives this description: 'Lip $\frac{3}{4}$ in. long, 3 lobed; side-lobes long, narrow, rounded, white-edged with a purple line; midlobe $\frac{1}{4}$–$\frac{3}{8}$ in. long, ovate, acute, yellow at base and white towards the tip, the margins subcrenulate, disk with 2 crested ridges.'

The following points become clear from the above: The lip of *E. reticosa* is 3-lobed, the side lobes are long, narrow, rounded and the midlobe is ovate, acute. In the new species the side lobes are very short, and the midlobe is oblong and rounded at the tip.

Locality: Panchgani, on perpendicular rocks of Tableland above Convent, also on rocks of Second Tableland, facing the monsoon-current, always in exposed situations (May Langham 231! type, Blatter 227!, 228!, 229! co-types); Lingmala, on tree (McCann!).

Flowered at the end of June 1925. Was also found flowering in other years about the middle of June, immediately after the breaking of the monsoon; also at beginning of July.

Fruit found on 1st September 1925.

In September new pseudobulbs were formed of the size of the old bulbs, surrounded at the base by 3 scarious sheaths. Sheaths broadly ovate, strongly nerved, suddenly contracted-acuminate; midrib very prominent below near the apex.

This species forms large dense patches, sometimes 0·5–1 m. across.

2. **Eria reticosa** Wight Ic. (1852) t. 1637; Hook. f. F.B.I. v, 787; Cke. ii, 690.—*E. uniflora* Dalz. in Hook. Kew Journ. Bot. iv (1852) 111.—*E. braccata* Dalz. & Gibs. Bomb. Fl. 262 (*non* Lindl.).—*E. braccata* Kränzl. in Engl. Pflanzenr. iv, 50, ii, B 21 (1911) 18, fig. 1, A-B. (*partim*); Fischer Fl Madras pt. viii (1928) 1425 (*partim*).

We cannot agree with Kranzlin and Fischer in uniting *E. reticosa* with *E. braccata* Lindl. We put the differences between the two species side by side.

	E. reticosa	*E. braccata*
Leaves	lanceolate or elliptic-lanceolate	oblanceolate
Pseudobulbs	netted	not netted
Sepals	acute	obtuse
Dorsal sepal	linear-lanceolate	oblong-lanceolate
Lateral sepal	falcate	nearly straight
Lip	3-lobed, at least obscurely	entire

In our opinion, these differences are sufficient to keep the two species separate.

Wight's plate 1637 of *E. reticosa* is, though not perfect, on the whole correct, and Wight's figure was drawn from the type specimen of *E. reticosa*.

We do not know what to make of Kranzlin's figure 1. Fig. 1 A is said to show the natural size. In the description the length of the sepals and petals is given as almost 3 cm. This size is reached not even in fig. 1 B which is said to be slightly enlarged. Then it is difficult to combine lip of fig. 1 B with its description '*labellum ligulatum vel oblongum, obtusum, lobi laterales obsoleti vel plica insiliente formati, vix conspicui.*' Besides, the bract which is correctly drawn in Wight's Ic. as touching the flower is removed a good distance from it in Kränzlin's fig. 1 A and still more so and quite without proportion in fig. 1 B. In the latter the shape, too, has been changed entirely.

Now it is possible that Kränzlin wanted to draw a specimen approaching the type of *E. braccata*, but then we would say that the shape and position of the bract certainly forms another distinguishing character between *E. reticosa* and *E. braccata*.

Kränzlin's *Nota* at the end of his description does not improve matters. '*Reichenbachius*' he says, '*optimo jure Eriam reticosam cum E. braccata conjunxit, labellum enim quod ex Hookero in E. reticosa trilobum in E. braccata simplex describitur, re vera formam praebet quae neque stricto sensu simplex neque triloba judicanda est, subtrilobum s. pseudotrilobum, margine* *laterali insiliente interrupto.*' We are afraid that the lip in his fig. 1 B is not even pseudo-trilobed.

Description : Cke. ii, 691.—The column is very short, more or less parallel-sided, straight. The anther terminal, surrounded along margin by a thin erect wall except where there is a membranous plate with upturned front-edge. Cap with 2 pockets, each holding 4 pear-shaped pollinia which are smooth and shiny (Bell MS.).

Locality : Konkan : (Woodrow !).—*W. Ghats:* (Dalzell ! Herb. Calc.); Mahableshwar, on tree (Sedgwick 7916 !); Lingmala, on rocks, 4,000 ft. (Sedgwick 7899 !), on tree (Sedgwick 4625 !); Lonavla, very common (Gammie !); Castle Rock, 1,800 ft., rainfall 300 in. (T. R. Bell 4336 !); Ramghat (Ritchie 707).

Distribution : W. Ghats from the Bababudan to the Nilgiri Hills at about 6,000 ft., High Wavy Mountains.

Flowers : June 1921 (Lingmala).

Fruit : August 1921 (Mahableshwar); September 1918 (Castle Rock); November 1918 (Mahableshwar).

3. **Eria Dalzellii** Lindl. in Journ. Linn. Soc. iii (1858) 47 ; Dalz. & Gibs. Bomb. Fl. 262 ; Gammie in Journ. Bomb. Nat. His. Soc. xvii (1906) 36 ; Cke. ii, 691 ; Kränzl. in Engler's Pflanzenr. iv, 50, ii, B 21 (1911) 19, fig. A–C (*partim*).—*E. filiformis* Reichb. f. in Wolp. Ann. vi, 268 (*partim*).—*Dendrobium filiforme* Wight Ic. v (1852) t. 1642 (central and top left-hand figs.).

Description : Cke. ii, 691.

Locality : Konkan (Stocks).—*W. Ghats:* Khandala (Hallberg 26520 !, Blatter & McCann 25839 !, McCann 25834 !, Blatter 25840 !) ; Lonavla (Chibber !) ; Panchgani (Herb. Econ. Bot. Poona !); Lingmala (McCann !).—*N. Kanara :* Yellapur, 1,500 ft. rainfall 100 in. (T. R. Bell 3909 !); near Karwar, on tree, sea-level, rainfall 120 in. (T. R. Bell 7873 !); Jog, on tree, 1,400 ft., rainfall 200 in. (Sedgwick 7171 !); without locality (T. R. Bell 4265 !).

Distribution : W. Ghats of Bombay and Madras Pres.

Flowers : July 1916 (Khandala); August 1918 and 1920 (N. Kanara); October 1919 (N. Kanara) September 1931 ; (Lingmala).

4. **Eria microchilos** Lindl. in Journ. Linn. Soc. iii (1858) 47 ; Gammie in Journ. Bomb. Nat. His. Soc. xvii (1906) 36 ; Cke. ii, 691.—*E. Dalzellii* var. *fimbriata* Hook. f. F.B.I. v, 789.—*Dendrobium fimbriatum* Dalz. in Kew Journ. Bot. iv (1852) 292.—*D. microchilos* Dalz. in Kew Journ. Bot. iii (1851) 345.—*Eria Dalzellii* Kränzl. in Engler's Pflanzenr. iv, 50, ii, B 21 (1911) 19 (*partim*).

This species was united by Hook. f. with *E. Dalzellii* Lindl. and Kränzl. l.c. has followed him. Gammie and Cooke keep the two species distinct. We agree with them. Gammie has pointed out the following differences :

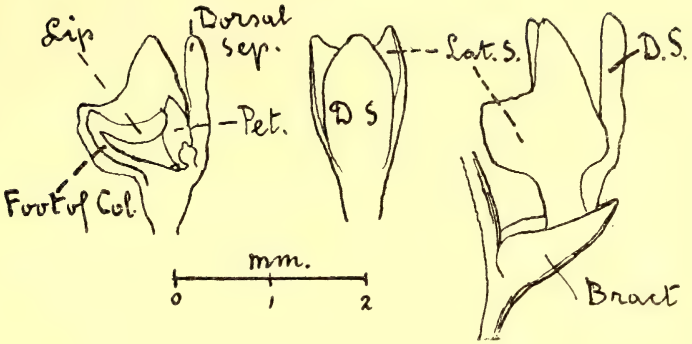
	E. Dalzellii	*E. microchilos*
Venation of pseudobulbs.	principal venation pinnate	principal venation flabellate.
Lip	ovate-lanceolate with 2 thickened ridges near base.	fiddle-shaped, the almost obsolete ridges extending to the middle of the lip, where they join to form a single line towards the apex.
Colouration of lip ...	green suffused with yellow on the basal half and white on the upper.	yellow on lower half and white on the upper.
Column	green	nearly white.

Description : Cke. ii, 691.
Locality : Konkan (Stocks, Gammie !); Wari country, on mango trees (Dalzell & Gibson).—*W. Ghats:* Khandala, on a boulder in a mountain stream, 2,500 ft., rainfall 250 in. (Hallberg !, Sedgwick 2645 !); Mahableshwar (Cooke!).
Flowers : July 1917 (Khandala).

5. **Eria minima** Blatter & McCann, *sp. nov.*
[*Pertinet ad sectionem Conchidii. Accedit ad Eriam exilem Hook. f. a qua tamen distinguitur scapo bracteato, bracteis late ovatis* (*non lanceolatis*), *floribus minoribus, sepalis æquilongis, pede gynostemii longo et labello relative longiore.*]
Description : A very small epiphyte, 1–3 cm. high. Pseudobulbs flat, irregularly orbicular or obovoid or broadly obovoid or rhomboid, adhering end to end like a chain, up to 12 mm. diam., grey or light olive-green when dry, with a membranous coat more or less reticulately veined, with a thickened margin. Leaves usually appearing after the flowers or with them, usually 2, sometimes 3, very variable in size and shape, obovate or oblong-obovate and tapering at base, or oblanceolate, or oblong, always rounded and apiculate at apex, always distinctly 7-or 9-nerved when dry, sheathing, very thin, light brown or olive when dry. Scape 1–3 cm. long, capillary, zig-zag, arising from between the leaves with a few minute sheaths at the base, bracteate at every bend of the axis (not nude as in *E. exilis*). Bracts broadly ovate-cordate, acute or apiculate or acuminate, hyaline, semi-amplexicaul, as long as the stalked ovary, 1–1·5 mm. long. Flowers minute, up to 6 in a raceme up to 10 mm. long, 1 at every bend of the axis, about 1·5 mm. long; distance between 2 flowers 1–2 mm. Sepals obtuse or subacute, all of the same length; dorsal oblong; lateral ones very broad at base, forming a stout saccate mentum almost as long as the upturned tips of the sepals. Petals small, oblong, half the length of the sepals. Lip oblong-ligulate, sessile on the foot of the column and incumbent, curved, longer than the petals, but shorter than the sepals. Column with an elongate foot. Anther ovate.
Locality : N. Kanara : Anmod, on trees 2,000 ft., rainfall 200 in. (Sedgwick 3260 ! type, T. R. Bell 4443 !) ; Siddhapur, 1,400 ft., rainfall 100 in. (Sedgwick 7269 !) ; Jog, on tree, 1,400 ft., rainfall 200 in. (Sedgwick 7170 !).—*W. Ghats :* Mahableshwar (Blatter & Hallberg B 1683 !, Sedgwick 7631 !, Ezekiel 26570 !, McCann !).
Flowers : October 1919 (Siddhapur, Jog) ; October 1920 (Mahableshwar) ; December 1907 (Anmod) ; February 1917 (Mahableshwar).

6. **Eria exilis** Hook. f. F.B.I. v. (1890) *et* Ic. Pl. xxi, t. 2074; Kränzl. in Engler's Pflanzenr. iv, 50, ii, B 21 (1911) 21; Fischer's Fl. Madras pt. viii (1928) 1425.—*E. microphyton* Schlechter in Fedde Repert. ii (1906) 170.
Description : A delicate plant, up to 10 cm. high. Pseudobulbs well approximate, ellipsoid, 1–1·3 cm. diam., leafless at time of flowering. Leaves unknown. Scapes arising near the apex of the pseudobulbs, slender, with some hyaline little sheaths, naked, 4·5–6 cm. high. Spike few-flowered (6–15). Bracts ovate-lanceolate, acuminate, hyaline, shorter than the flowers. Flowers white. Sepals oblong, acute, scarcely 3 mm. long, connate for the lower ¼, lateral ones oblique. Petals obliquely lanceolate-elliptic, narrowed towards the base, slightly shorter than the sepals. Lip oblong-ligulate, obtuse, glabrous, arcuate, slightly shorter than the petals. Column short ; foot almost absent ; clinandrium entire ; rostellum wide, ascending, triangular, obtuse ; another broadly ovate, obtusely apiculate in front, glabrous ; pollinia 8, pyriform, oblique ; ovary short-pedicelled, glabrous, 2 mm. long.
Locality : Mahableshwar (Cooke ! in Herb. Calc.).
Distribution : Travancore, Ceylon, Siam.

7. **Eria polystachya** A. Rich. in Ann. Sc. Nat. 2 sér. xv (1841) 20, t. 9; Hook. f. F.B.I. v, 792; Kränzl. in Engl. Pflanzenr. iv, 50, ii, B 21 (1911) 64; Fischer Fl. Madras pt. viii (1928) 1425.—*E. pubescens* Wight Ic. t. 1635.—*E. mysorensis* Lindl. in Journ. Linn. Soc. iii (1858) 54; Hook. f. F.B.I. v, 793; Gammie in Journ. Bomb. Nat. Hist. Soc. xvii (1906) 37; Cke. ii 692.
Description : Cke. ii, 692.


Lip
Dorsal sep.
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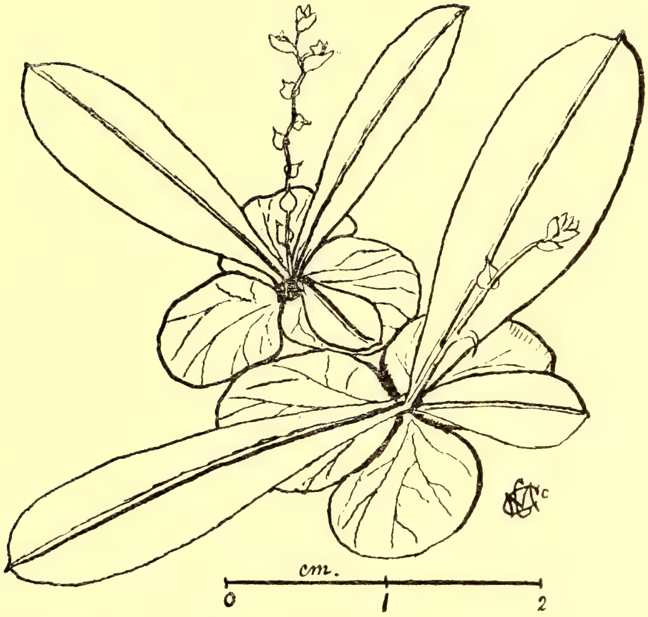

Eria minima, Blatter & McCann, *sp. nov.*

Locality : Konkan : (Stocks).—*W. Ghats :* (Gammie !) ; Mahableshwar (Gammie !, James !, Herb. Calc. Woodrow !) ; Koina Valley below Mahableshwar (Cooke !, Herb. S.X.C. 26521 !).—*S.M. Country :* Dharwar (Law).
Distribution : W. slopes of the Nilgiris, Bababudan Hills, Malabar, Travancore, Maldives, Ceylon.

8. **Eria pubescens** Wight Ic. (1856) 1634, *in tab. E. polystachya dicta ;* Hook. f. F.B.I. v, 793 ; Kränzl. in Engler's Pflanzenr, iv, 50, ii, B 21 (1911) 64.
Description : Pseudobulbs short, ellipsoid, as thick as the thumb. Leaves pubescent, soon deciduous, up to 15 cm. long, 2 cm. broad, lanceolate. Racemes arising from amongst the leaves, slightly drooping, longer than the leaves, sparingly puberulous. Flowers 1·2–1·6 cm. long, 2 cm. diam., white, tipped with pink. Sepals lanceolate, acute, 5-7-nerved, white with pale streaks, dorsal one longest, mentum almost none. Petals linear-lanceolate, acute, 5-nerved. Lip entire, much broader than the sepals, ovate-cordate, acute, slightly sinuate on both sides, with purple blotches and yellow tip, 2 low short ridges in the lower third of the base of the disk ; column short, no stelidia.
This species is very nearly related to *E. polystachya* A. Rich., but can be readily distinguished by its pubescent leaves, its much larger leaves and 5-7-nerved, white and pale streaked sepals.
Locality : W. Ghats ; Mahableshwar (Hallberg !).
Distribution : W. slopes of the Nilgiris.

(*To be continued*)

THE LONG-TAILED MACAQUE MONKEYS (*MACACA RADIATA* AND *M. SINICA*) OF SOUTHERN INDIA AND CEYLON.

BY

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Examination of the Bonnet Monkeys collected in the Eastern Ghats and a comparison of them with the splendid series of skins and skulls previously collected by the Mammal Survey in various parts of South India yielded so many interesting results, never before recorded, that I was induced to take up the study of the Ceylon species as well. My observations and conclusions are set forth in the following pages.

THE BONNET MACAQUE (*Macaca radiata*).

The Colour-variations of the Bonnet Macaque.

In view of the evidence I have discovered for the existence of more than one race of this monkey in India, it must be recalled that Geoffroy's description of his example as 'brun-verdatre' fixes the colour of the typical sub-species or local race. I consequently assign to this race *(M. radiata radiata)* a number of specimens, obtained in several districts by the Survey, which exhibit various shades of olive-brown.

A hasty inspection of the skins suggests at first the occurrence of local races of this type; but the available evidence points to the conclusion that the marked differences in tint are due to seasonal change. Unfortunately it was not possible to collect throughout the year a series of examples attesting month by month the changes in colour and coat in one locality. When this is done for various districts, it may prove that more than one race is represented by the olive-brown type. But at present there is not sufficient material to justify, in my opinion, that conclusion.

The general tint of the winter coat on the dorsal area is deep brown or olive-brown with little, if any, pale ticking or speckling in the hair. The long radiating hairs on the bonnet and the short hairs diverging from the middle line of the forehead in front are greyish brown at the base, blackish distally. The outer sides of the arms are rather paler than the back, there being more grey in the hair; and the legs and feet are greyer than the arms. The tail is black above in its basal half, turning to deep brown distally.

The under side and inner side of the limbs are clothed with whitish grey hairs which show up conspicuously on the black pigmented skin of the chest and abdomen.

In the spring and early summer the long hairs of the upper side fade through the greater part of their length to a pale buffish tint giving a decidedly pale olive-grey or buffy grey colour to the skins. The hair then looks dull, lustre-less and shaggy and is decidedly coarser to the touch than the rich brown coat of mid-winter.

The following skins may be referred to in illustration of this summary of the seasonal colour-changes.

An adult male and female shot on December 20 by Shortridge on the Haleri Estate, N. Coorg, 3,555 ft., have the coat long and soft, deep brown in colour with scarcely a trace of pale speckling in it. Two obtained by J. A. Graham at the same place on January 16, have the coat somewhat coarser and paler.

An adult male from Ghatmatha, Satara (S. H. Prater), dated December 17, is also a deep olive-brown with inconspicuous ticking on the nape and shoulders.

A male and three females from Dharwar, 2,300 ft., (G. C. Shortridge), November 14, are very like the Satara specimen but a little paler.

Six specimens, an adult male and five females, from Samasgi the Kanara Boundary, S. W. Dharwar, 2,000 ft., (G. C. Shortridge), on March 12th, have the coat on the average longer, shaggier and much paler owing to an extensive pale buffish-olive area on the hairs.

A female from Karumbapatti, Salem, April 21st, and a male and two females from Malakondapenta in the Kurnool District, May 14th (N. A. Baptista), have the coat long and shaggy, consisting of dead hair extensively olive grey in colour. At a little distance these skins appear to represent a sub-species easily distinguishable from the one represented by the deep brown skins from Satara and the Haleri Estate in North Coorg; but the differences between them and the series from Samasgi in S. W. Dharwar are comparatively slight.

The examples in the British Museum I assign to this race were collected in the following districts:—

Satara (*S. H. Prater*). Dharwar 2,300′, Kanara 2,000′, (*G. C. Shortrdge*), Kurnool (*N.A. Baptista*), Mysore, Devikop in S. Mahrata, N. Coorg 3,555′, S. Coorg 2,000′ (*G. C. Shortridge*), Shevaroy Hills 4.500′ (*N. A. Baptista*), Nilgiri Hills 5,120′ (*P. Gosse*), Kodaikanal 5,500′ (*C.McCann*), Cochin 1,500′ (*R. O'Brien*), Palni Hills 3,000′-4000′ (*R. O'Brien* and *C. McCann*).

There are, however, a few specimens from other localities which deviate from them in certain particulars regarding colour. For example, a full-grown male from Vijayanagar in Bellary 1500′, obtained by Shortridge on August 12th, can be picked out at once by the distinct yellowish speckling giving a greener aspect to the pelage, the bonnet and forehead and the base of the tail are not so dark and the legs below the knees are greyer. But a young male from the same place, shot on August 4, is like the series from Dharwar.

Very similar greenish yellow speckling may be seen in two examples obtained by J. Riley O'Brien on May 28th at Shernelly in Cochin 1,500′. Superficially these examples are tolerably uniformly olive-brown in colour, the coat being dull and in process of moulting. But the speckling is revealed in the newly erupting hair when the old coat is parted.

These markedly yellow-speckled specimens coming from widely separated districts may for the present be set aside as varieties.

A pale example of a different type, an immature female from Cumbum in Madura obtained by S. H. Prater on May 17th also looks suggestively different with its annulated hairs from the typical form. But that too must be set aside.

Another specimen, a sub-adult female collected by G. C. Shortridge on May 27th at sea-level below the Gersoppa Falls in Kanara, differs from the typical form in exhibiting a decidedly reddish-brown tinge especially on the flanks, shoulders and sides of the neck, and to a lesser degree on the limbs and tail. As may be inferred from the date the pelage is lustre-less and no doubt faded. Probably the reddish tint would have been brighter five or six months earlier. A young one, collected with her, is, however, normally tinted. She measured in the flesh: head and body 1 ft. $6\frac{2}{5}$ ins., tail 1 ft. $9\frac{3}{5}$ ias.; total 3 ft. 4 ins., and her weight was 9 lbs.

Provisionally at all events I treat this example as an erythristic sport. It is, however, the only representative of this monkey taken at sea-level that I have seen; and the interest of the coloration lies in its approximation to that of the Ceylonese Toque. Possibly the record of the Toque from India by Gray was due to his knowledge of similar reddish specimens of the Bonnet. The skin is quite as red on the back as some specimens of the Toque, but it does not show the redness of the thighs observable in the brownest examples of the Ceylonese species.

Two specimens appear to represent a distinguishable local race, which may be described as follows:—

Subsp. *M. radiata diluta* nov.

Differs from typical *M. radiata* in being much paler in tint throughout. The hairs of the forehead are buff with darker tips, those of the 'cap' are a pale brownish buff without dark tips but grey at the base. The hairs of the neck and shoulders are long and, like those of the rest of the back, have long buff tips. The arms, legs and tail are correspondingly paler and buffier. The hairs of the belly and of the insides of the limbs instead of being whitish grey are creamy white, and the skin of the chest and abdomen is pallid, not dark blackish grey.

Locality: Boothapaundy in Travancore.

Two female examples, one nearly adult, the other younger, obtained by R. S. Pillay on November 18. The skins are in good coat and differ noticeably in their paler coloration from examples of typical *radiata* shot by Shortridge on November 14 at 2300′ in Dharwar. They more nearly resemble the pallid, faded skins obtained on March 12 at Samasgi in S. W. Dharwar and those from

Salem and Kurnool obtained on April 21 and May 14 respectively, but are not the same tint above and are noticeably different from them and from all the skins of typical *radiata* obtained at various months of the year by the absence of dark pigment in the integument and by the creamy tint of the hairs of the under side.

The dimensions of the two skins, the adult measuring : head and body 1′ 4⅘″, tail 1′ 10⅘″, total 3′ 3⅗″, and the younger: head and body 1′ 1⅗″, tail 1′ 9″, total 2′ 10⅗″, show that this monkey is as large as typical *radiata*, a conclusion borne out by the measurements of the skull of the type entered on the subjoined table.

The measurements and weights, taken in the flesh, of some of the examples of *M. radiata*, collected by the Mammal Survey, are as follows :—

Locality and Sex		Head & Body	Tail	Total	Weight	Remarks
Vijayanagar, Bellary,	♂ ad.	1′ 11⅘″	2′ 3″	4′ 2⅘″	19½ lbs.	Typical *radiata.*
Dharwar,	♂ ad.	1′ 10⅘″	2′ 0⅘″	3′ 11⅗″	...	,,
Haleri Estate, N. Coorg,	♂ ad.	1′ 9⅕″	1′ 8″	3′ 5⅕″	13 lbs.	,,
Samasgi, Kanara,	♂ ad.	1′ 9⅕″	1′ 10⅗″	3′ 7⅗″	14½ lbs.	,,
Ghatmatha, Satara,	♂ ad.	1′ 8⅕″	2′ 1⅗″	3′ 9⅘″	16 lbs.	,,
Dharwar,	♀ ad.	1′ 8⅗″	1′ 10⅗″	3′ 7⅕″	...	,,
Samasgi, Kanara,	♀ ad.	1′ 7⅕″	1′ 8⅘″	3′ 4″	8½ lbs.	,
Haleri Estate, N. Coorg,	♀ ad.	1′ 6⅕″	1′ 5⅕″	2′ 11⅖″	8½ lbs.	,
Wottekolle, S. Coorg,	♀ ad.	1′ 6″	1′ 8⅕″	3′ 2⅕″	...	,,
Boothapaundy, Travancore,	♀ ad.	1′ 1⅕″	1′ 9″	2′ 10⅕″	...	Type of *diluta.*

With regard to general superiority in size of the males over the females, this table confirms the table giving weights and measures of the specimens collected in the Eastern Ghats. The two sexes do not always differ greatly in actual length, but males are always considerably heavier. The specimens enlisted above are the largest procured. Special attention may be drawn to the very big male shot by G. C. Shortridge in Bellary and to the big female, as long as many males, obtained by him in Dharwar. The female from Samasgi is the largest of a series of six, the weights of the others being 8 lbs. The tail, it may be seen, is as a rule longer than the head and body. Where it is shorter, the great possibility of artificial abbreviation must be borne in mind.

The Skull of M. radiata.

Blanford described the skull of this monkey as 'long, flattened over the brows with the orbits much broader than high and vertical,' and he gave the total length and zygomatic width of the skull of an adult male as 4·8 inches (=120 mm.) and 3·5 inches (=87½ mm.) respectively. Since all the skulls of adult males I have measured are much narrower across the cheek-bones and have the orbital sockets approximately circular and sometimes higher than wide, I have no doubt that he selected for measurement one of the several skulls, in the British Museum, of examples of this monkey that had been reared in captivity, probably in the Zoological Gardens. These may be distinguished at once by their low brows, imparting a peculiarly scowling aspect to the skull, as well as by other characters from the skulls of wild-killed specimens. Blanford's record is therefore valueless.

The following table gives some dimensions in millimeters of male and female skulls of the two races recorded above. The table shows the difference in cranial size between the males and females of *M. radiata* and also some of the individual differences between members of the same sex:—

Locality and Sex		Total length	Zygom Width	Orbital Width	Upper Molars	Lower Jaw	Remarks
Coorg	♂ ad.	121	78	61	32	87	Typical race.
,,	♂ ad.	119	77	57	31	86	,,
Nilgiri Hills	♂ ad.	117	80	65	30	84	,,
Kotagiri, Nilgiris	♂ ad.	116	77	59	31	80	,,
Coimbatore	♀ ad.	105	67	56	29	72	,,
Coorg	♀ old.	105	72	58	29	73	,,
,,	♀ old.	103	68	54	30	71	,,
Kotagiri, Nilgiris	♀ old.	104	69	55	30	...	,,
Dharwar	♀ ad.	102	69	55	30	73	,,
,,	♀ ad.	99	63	51	28	69	,,
Kanara (sea-level)	♀ young	100	...	53	...	...	Reddish variety.
Travancore	♀ ad.	105	72	56	28	...	Type of *diluta*.

Apart from size, the two adult male skulls from Coorg differ in the shape of the palate and of the orbits. In the larger example, the rows of cheek-teeth are approximately straight and parallel, and the orbital sockets are nearly circular, measuring 20 by 20 mm. In the smaller the rows of cheek-teeth are noticeably arcuate and the orbital sockets are higher than wide, measuring 22 by 20 mm. Female skulls may, of course, be at once distinguished from male skulls by their small canine teeth, accompanied by a narrower and shorter muzzle. In shape they resemble the skulls of sub-adult males; but the cheek-teeth are only slightly shorter than those of males, and the orbital sockets are quite as large.

THE TOQUE MACAQUE (*Macaca sinica*).

Examination of the specimens of the Bonnet Macaque suggested a revision of the specimens in the British Museum, mostly obtained by the Mammal Survey, of its Ceylonese ally the Toque Macaque (*M. sinica*). The skins proved a puzzling series and perhaps the following remarks about them may prove of interest:—

Differences between the Bonnet and the Toque Macaques.

The degree of kinship between these two monkeys has always been open to doubt. Most authors have treated them as distinct on account of the prevalent difference between them in colour and the alleged difference in size, the Ceylon form being redder and smaller than the Indian. Such characters, however, have only a sub-specific value in the case of the Crab-eating Macaque of Malaya and the Sunda Islands; and Blanford, after describing the Bonnet and the Toque, said 'it is very doubtful if there is any constant difference, [between them]. For my own part, I doubt if the two are entitled to specific distinction.' Hinton and Wroughton, however, claimed that, apart from its red colour, the Toque may be distinguished by the forward growth of the hairs up to the eyebrows on the forehead, the corresponding hairs in the Bonnet diverging sideways from a median parting.

Comparison of the skins in the British Museum shows that none of these three characters is absolutely distinctive and constant. But there is one difference, hitherto unnoticed, which appears to admit of no exception. In the Bonnet Macaque, the hair on the cheek in front of the ear grows upwards from the throat and lower jaw to the level, or nearly so, of a line running from the eye to the summit of the ear where the tips meet those of the hairs of the crown which diverge transversely from the middle line. In the Toque Macaque, the hairs on the cheek in front of the ear slope obliquely downwards and backwards and meeting the upwardly growing hair from the throat and lower jaw form a distinct whorl on the cheek and often a definite crest below the ear. This whorl varies in size and distinctness, possibly due in part to the 'make-up' and shrinkage of the skins; but it is always detectable.

Variations in the Toque Macaque.

The available skins of this monkey are not sufficient to supply a full explanation of the variations in general colour and in the growth of the hair on the forehead.

A series of five collected by Major E. W. Mayor between September 24th and October 4th at Mankeni on the coast of the Eastern Province, may be selected as a basis for comparison.

Two adult males, weighing 12 lbs. and 10 lbs. respectively, have the fore part of the back reddish brown; this tint increases in brightness on the hind back and loins and is especially bright, almost orange, on the outside of the thighs and shoulders but becomes duller and dies away distally on the limbs, the arms being brighter than the legs. The tail is greyish brown to blackish above, speckled with orange at the base. On the head the 'cap' consists of long radiating hairs, greyish below and yellowish buff at the tip, which overlie and mostly conceal laterally and in front a fringe of shorter hairs rendered conspicuous by a bright orange band preceding the black tip. The hairs of this fringe, which narrows in front, grow forwards up to the eye-brows. The cap is set off by greyish hairs on the cheek and over the ear. The under side of the body and tail and the inner sides of the limbs are clothed with whitish grey hairs.

A half-grown male, weighing 6 lbs., resembles the adults in colour; but the fringe does not cover the forehead, a short area behind the eye-brow being covered with hairs growing backwards and outwards.

A female, unmeasured and undated, has the brow as in the young male; but the pelage is less brightly coloured than in the males.

A very young male, weighing only 2 lbs., is well coloured, but has the long hairs of the cap much shorter and not overlapping the forehead which is covered to the brow with short hairs directed forwards and outwards, there being no definite orange-edged fringe.

Compared with this series an adult female from Tellula 300,' in Ura, shot in April, and an adult female from Wellawaya in Ura, shot in July, are as richly coloured as the adult males from Mankeni and have the forehead similarly covered to the brow by the orange-edged fringe. The coat in the female from Wellawaya is, however, a little longer. A young one killed with her is also very like the young one from Mankeni.

In north western Ceylon Major Mayor also secured some interesting specimens. An adult male shot at Cheddikulam on November, 11th has the forehead covered to the brows as in the adult males from Mankeni; but the margin of the fringe is dull buffy yellow, not bright, and the general colour of the head, shoulders, back and arms is yellowish olive without a trace of red. The only red present in the pelage is on the outer side of the thigh, which is orange but not so bright as in Mankeni specimens.

A younger male, three-quarters grown, from the same place and shot on November 26th, is dark brown in hue, also without any bright yellow or orange in the pelage, but a note on the label states that the coat was discoloured by the firing of a lamp in the drying shed. It may be noted, however, that the normal grey of the under side is unaltered. In this younger specimen the area behind the eyebrows is uncovered by the cap, its hairs being directed outwards and backwards.

This specimen closely resembles in its brownish tint a young male shot at Kala Oya, N.C.P., in May; and here also the fore part of the forehead is uncovered by the cap. The forehead is similarly uncovered in a sub-adult female, weighing 6½ lbs., shot at Tammanewa in May; but this specimen is as brightly coloured as the Mankeni series.

The specimens so far described carry no convincing evidence of seasonal colour-change, bright typically coloured reddish-orange tinted specimens being met with in April, May, July, the end of September and the beginning of October. But such evidence is supplied by two examples obtained at Maha Oya in the Eastern Province in August. A sub-adult male, weighing 9 lbs. shot on August 12, has a good deal of the typical orange hue on the thigh, but the coat on the back is short and coarse and dark olive-brown in hue. Beneath it, however, the new coat, with characteristic orange speckling, may be seen sprouting. A younger male, shot on August 17 at the same place, shows the same phenomenon but is redder on the loins and thighs. The cap and fringe on the head in these examples are respectively very similar to those of the adult males and the baby from Mankeni.

Passing reference may here be made to an immature female from Hambantota on the coast of the Southern Province, received many years ago from the Colombo Museum. It is a dark coloured monkey recalling in colour and the uncovered brow the example from Cheddikulam at the northern end of the island. In the tolerably uniform dusky tint of the long radiating hairs of the 'cap', this Hambantota example resembles those described above from the northern and eastern parts of the island; but two other specimens from the Southern Province differ considerably from it in that respect and from each other in other particulars.

An adult, or sub-adult, female from Ranna, collected on May 17, has a large area of the forehead behind the eyebrows covered with short backwardly directed hairs of a yellowish grey hue, and the long radiating hairs of the anterior half of the cap are buffy throughout, a little paler at the tips, and contrasted with the duskier radiating hairs of the hinder half of the cap. The hairs of the neck, shoulders and arms are, moreover, paler than usual, being golden buff rather than orange or red, and these areas are brighter in tint, not duller, than the hinder part of the back.

A young half-grown male, weighing 4½ lbs., from Kottawa on the coast of the Southern Province, is very different from the example from Ranna and in general colour recalls the specimens from Mankeni, but is more brightly tinted, the orange red being everywhere much in evidence in the long coat, and the bases of the hairs are blackish grey. The forehead too is covered to the eyebrows by a fringe of forwardly directed hairs as in the full-grown male examples from Mankeni. But the hairs of this fringe are bright orange throughout; and the long cap of radiating hairs is markedly two-coloured, the hairs of the anterior half being bright orange buff throughout, whereas those of the posterior half are greyish with buff tips and contrast markedly in tint with the hairs of the fore-part, an exaggeration of the same feature exhibited by the Ranna specimen.

An adult female collected by W. W. Phillips on January 15 at Anasigalla Matugama in the Western Province, also has the anterior part of the cap all buff as in the Ranna and Kottawa specimens. The coat is long as in the Kottawa specimen, but it is only conspicuously red on the loins and thighs, the fore part of the back and the neck being dull brownish, much darker than in typical forms.

Finally, the flat skin of an adult male obtained by Major E. W. Mayor at Roygam Korali, in the Western Province, resembles the example from Kottawa in all essential particulars, i.e., the colour of the cap, the intensification of the orange redness everywhere and of the deep bluish black of the basal part of the hairs. Unfortunately it is undated and unmeasured.

I have described these specimens at some length to illustrate the great variability of the species in colour and in the growth of the hair on the top of the head, two features by which it has been claimed that *M. sinica* may be distinguished from *M. radiata*. The specimens show that the general hue of the body may be almost identical with that of the Indian species, and that the forehead behind the eyebrows may resemble that of *radiata* in the direction of growth of the hairs.

All that can be said of the differences between the two species so far as these features are concerned is that in *M. sinica*, there always seems to be a certain amount of orange-red on the thighs, and that the short-haired area between the eyebrows and the 'cap' is at all events on the average smaller than in *M. radiata* and seldom exhibits so conspicuous a median parting.

The following table shows the weights and measurements, taken in the flesh, of some adult or almost adult examples of *M. sinica*:—

Locality and Sex	Head & Body	Tail	Total	Weight
Cheddikulam, ♂ ad.	1′ 6⅖″	1′ 10⅖″	3′ 4⅘″	10¼ lbs.
Mankeni, ♂ ad.	1′ 7⅕″	1′ 11⅖″	3′ 6⅗″	12 lbs.
Mankeni, ♂ ad.	1′ 5⅗″	1′ 9⅗″	3′ 3⅕″	10 lbs.
Kala Oya, ♂	1′ 5⅘″	1′ 8″	3′ 1⅘″	9 lbs.
Wellawaya, ♀	1′ 4⅘″	1′ 10″	3′ 2⅘″	...
Ranna, ♀	1′ 4⅕″	1′ 7⅖″	2′ 11⅗″	...
Matugama, ♀	1′ 4″	1′ 10″	3′ 2″	...

Although the available skins of adult examples of this species is small, this table, when compared with the table on p. 279, bears out the claim put forward by Kelaart that the Ceylonese species is smaller at least on the average than its Indian ally.

I agree with Blanford that there is no character by which the skulls of *M. sinica* can be distinguished from those of *M. radiata*. In both species, the skulls are liable to a good deal of individual variation.

The following table gives a few of the dimensions in millimetres of some of those that I have examined :—

Locality and Sex	Total Length	Zygom. Width	Orbital Width	Upper Molars	Lower Jaw
Koliyagalla, ♂ ad.	117	78	67	30	83
Mankeni, ♂ ad.	112	...	...	27	81
,, ♂ ad.	110	79	62	31	82
Tellula, ♀ ad.	96	64	52	27	68
Matugama, ♀ ad.	95	...	...	27	...

These skulls bear out the evidence supplied by the skins that the average size of *M. sinica* is less than of *M. radiata.*

The two skulls from Mankeni differ considerably when viewed from the front. In the smaller the orbits are circular, measuring 21 by 21 mm., and the orifice of the nostrils is 11 mm., whereas in the larger the orbits are noticeably wider than high, being 21 by 17 mm., and the aperture of the nostrils is 14 mm.

Revising the facts, set forth above, relating to the coloration of examples of this species obtained in various parts of Ceylon, it must be admitted that many of the variations must be set aside as unexplained until more specimens come to hand.

The evidence, however, supports three conclusions :—

(1) The two specimens from Maha Oya show that the moult begins in August and is accompanied by a marked change in colour when the old brown coat is replaced by new hair with conspicuous orange annulation yielding the red tinge characteristic of typical *sinica.*

(2) There is a general increase in the redness of the pelage from north to south, the difference in colour between the adult males from Cheddikulam and Roygam Korali being very striking.

(3) It also seems that examples from the south-western part of the island differ from those from the northern and eastern parts by the tint of the radiating hairs of the cap, a feature particularly noticeable in the very rich red specimen from Roygam Korali, in which the hairs of the anterior half of the cap are noticeably reddish from base to tip.

These facts I think supply evidence for the existence of three distinguishable local races of *sinica*, a conclusion enforcing a decision regarding the coloration of the cap and coat in typical *sinica* for which unfortunately no locality was known. Reliance must in consequence rest upon the descriptions of the Macaque monkey Buffon described as ‘ Le Bonnet Chinois ’ to which Linnæus gave the name *Sinica* under the mistaken belief that it came from China. By both Schreber (*Die Saügth.* I, p. 108, 1775) and Audebert (*Hist. Nat. Singes*, Fam. 4, sect. II, p. 17, 1799), this monkey was described as red; but neither their descriptions nor their coloured plates indicate that the cap, or bonnet, of radiating hairs was anything but uniformly coloured throughout. I propose, therefore, to restrict *sinica* as a subspecific term to the red examples with uniformly tinted bonnets with dusky buff-tipped hairs. The examples above described from Mankeni and elsewhere farther south in the eastern part of the island may be taken as representative of this race.

The two new races I propose to admit may be named and described as follows :—

Subsp. *inaurea* nov.

Resembling the typical form *sinica* in having the hairs of the anterior and posterior halves of the bonnet alike in colour, but distinguishable by the absence of red from the pelage, apart from the outside of the thighs, the general hue of the head, shoulders, back and arms being yellowish olive, the hairs being merely annulated with greyish buff.

Locality and history of type: Cheddikulam (N. P.), north of Adams Bridge. An adult male collected by Major E. W. Mayor.

Since this example was killed in November, just after the August-September moult, the absence of yellow or orange annulation in the hairs cannot be assigned to fading. A second, younger example, also killed in November at Cheddikulam, similarly lacks the red speckling, but is browner than the type. The skin, however, is said to have been artificially discoloured. A still younger specimen shot in May at Kala Oya to the south of Cheddikulam is also brown without red speckling; but at Tammanewa, near Kala Oya, the red race occurs.

The likeness in colour between this northern race of *sinica* and the Indian *M. radiata* is interesting.

Subsp. *aurifrons* nov.

Resembling typical *sinica* in the redness of the pelage but brighter coloured, the hairs long, almost purplish black at the base with bright orange-red tips, the arms comparatively brightly speckled to the hands, the outside of the thighs and lower leg almost fiery red, the feet yellow. Hairs of the bonnet very long, those of its anterior half reddish from the base to the tip, of the posterior half dusky greyish at the base, reddish at the tips.

Locality and history of type: Roygam Korali (W. P.) Flat skin of an adult male sent by Major E. W. Mayor, but undated and unmeasured.

A young male from Kottawa (S. P.) agrees very closely with the type in its long coat of bright red and deep black hairs, and it has a frontal fringe wholly golden red throughout. This fringe is concealed in the flat skin from Roygam Korali.

Examples from Ranna and Anasigalla Matugama also have the hairs of the fore half of the bonnet of a uniform colour, without dusky bases, thus differing from the hairs of the hinder part; but they show none of the vivid coloration of the two specimens assigned to *aurifrons* and cannot at present be certainly included in the sub-species.

SUMMARY.

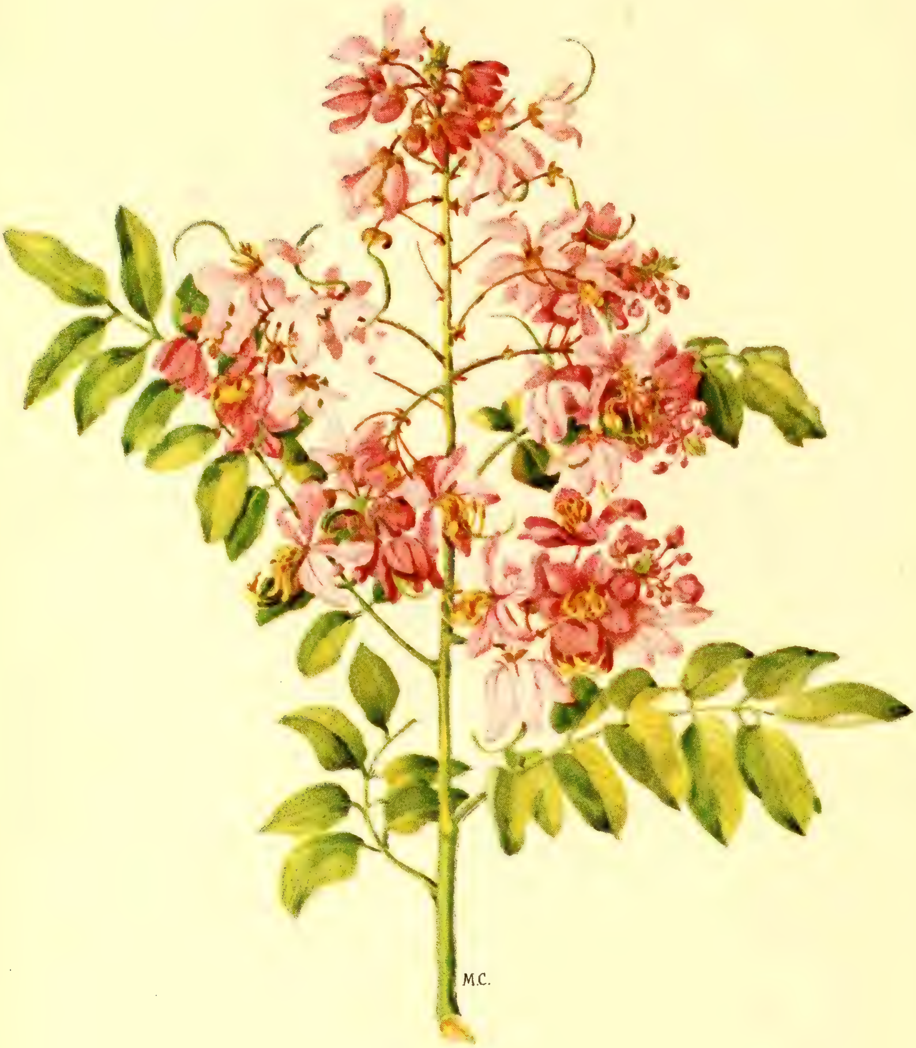
The following analytical key setting forth the distinctive characters of the different kinds of long-tailed Macaques from South India and Ceylon will serve as a summary to this paper.

A. Hairs on the cheek growing upwards from the throat and lower jaw to the level of the top of the ear, or nearly so, not forming a whorl on the cheek; typically a larger short-haired area between the bonnet and the brows; red usually absent from the pelage, never specially in evidence on the outside of the thighs; size on the average larger	*Macca radiata.*
(a_1) General colour of the winter coat brown or olive-brown, at most faintly speckled, fading to buffy or greyish brown before the summer moult; hairs on under side whitish grey; skin of belly blackish.	Subsp. *radiata.*
(a_2) General colour of the winter (Nov.) coat much paler, markedly buffy throughout; hairs of under side pale cream; skin of belly pallid, without dark pigment ...	Subsp. *diluta.*
B. Hairs on cheek in front of ear growing downwards and backwards and forming a distinct whorl on the cheek where they meet the upgrowing hairs from the throat and lower jaw; hairs on the forehead very variable but typically a shorter area of short hairs between the bonnet and the brows; pelage usually ticked with yellow or red, always so on the outer side of the thigh; size on the average smaller... ...	*Macaca sinica.*
(b_1) General colour brownish olive, annulation of hair yellowish brown, not bright; hairs of the bonnet alike throughout	Subsp. *inaurea.*

(b_2) General colour much brighter, annulation of hair orange, yellow or red, altogether more vivid ... ...

(c_1) Long radiating hairs of the bonnet all alike, greyish at base with buffish tips; hairs of the back not so black at the base or red at the tips ... ... Subsp. *sinica*.

(c_2) Hairs of the anterior half of the bonnet uniformly reddish from base to tip, strongly contrasted with those of the posterior half; hairs of the back redder and blacker ... ... Subsp. *aurifrons*.



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THE JAVA CASSIA
Cassia javanica, Linn.
(about ½ nat. size)

SOME BEAUTIFUL INDIAN TREES.

BY

E. BLATTER, S.J., Ph.D., F.L.S., AND W. S. MILLARD, F.Z.S.

PART VII.

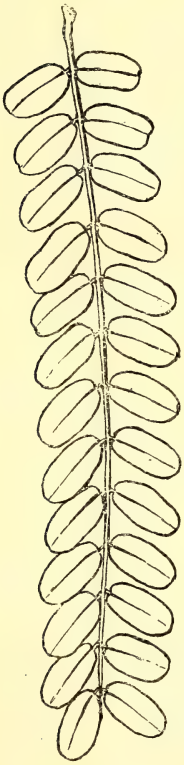
(*With two coloured plates, three black and white plates and 7 diagrams.*)

(*Continued from page 65 of this volume.*)

THE JAVA CASSIA.

Popular names : Java Cassia, Javanese Cassia (Engl.); Dulang.

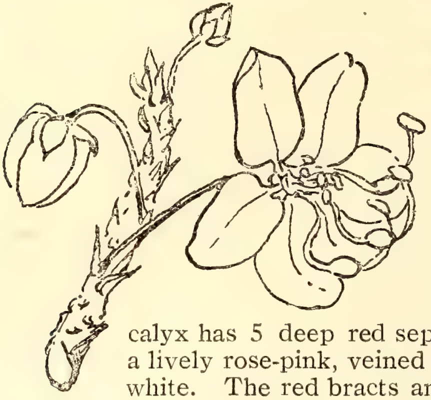
Cassia javanica Linn. Sp. Pl. (1753) 379.



Description : Roxburgh describes this Cassia as the most beautiful he has ever seen. It is a medium sized tree. Its straight trunk, covered with smooth, dark brown bark, supports a spreading crown of sturdy, horizontal branches and numerous, drooping feathery-leafed branchlets. The leaves are from 6 to 12 inches in length. At the base of the leaf-stalk is a crescent-shaped stipule. Its lower half is narrow, the upper half is broader with a spur in a notch at its apex. A large leaf is composed of from 8 to 14 pairs of leaflets; on the smaller leaves growing on the lateral flower-bearing branchlets there may be no more than 2 to 4 pairs. These leaflets are 1 to 2 inches in length and about half that in breadth. They are all very short-stalked, oblong-oval in shape and rounded or blunt at the tips. There is much variation in the shape of the leaflets, mostly they are blunt at the apex but in some this character is less pronounced. In texture they are smooth and silky, the under surface being covered with a mat of downy hairs. They are quite glossless. Leaf fall commences in December, some of the leaves turn a bright yellow; by February most of the branches are bare—their only ornament is the blackened seed pods. The soft tender green leaves come out in May together with clusters of deep pink buds. The buds are grouped in whorls at the end of short, lateral branchlets. These presently opening form lovely bunches of rose-pink flowers. In its crown of tender green leaves and flower laden branches the Java Cassia is indescribably beautiful. The distinct clusters of flowers intermingled with the foliage is a character which distinguishes the flowering of this Cassia from the Pink Cassia

4

(*C. renigera*). In the latter the flowering branches are leafless. Except for a few leaves at the extremity they are covered with a flow of pink and white blooms in which the individual clusters are not readily discernible. In *Cassia javanica* each cluster of flowers contains about 10 blooms growing on long, slender stalks. At the base of each stalk is a leafy, dull-red heart-shaped bract. The calyx has 5 deep red sepals. The oblong petals are of a lively rose-pink, veined in deeper pink. They fade to white. The red bracts and sepals, the deep pink buds, the pink and white of the petals give the clusters a lively, variegated appearance. There are 10 bright yellow stamens. The 3 lower stamens are long and prominent. They project in a double curve, swell out markedly in the middle and then bend inwards. They are crowned with large brown anthers. The anthers on the smaller stamens are yellow. All of them are fertile. The style is green.



The pods grow from 15–24 inches in length ; externally they differ in no way from those of the Indian Laburnum (*Cassia fistula*). The only distinguishing feature is the soft sweet pulp of *C. fistula*. In a pod of the Java Cassia the space between the partitions—there are 70 to 80 of them—is filled with a spongy mass in which there is a roomy cell for a flattened seed, the size of a pea, smooth and of a shiny brown colour.

Flowering season : The tree flowers in May and by mid June the height of the flowering season is past and the ground below the tree is strewn with fallen petals. The seed pods ripen about February. This is another of the beautiful trees which, during the hot weather, brighten the roadsides and gardens of Bombay where it was introduced about the year 1910. Mr. Kemball was prominent in introducing it. Unfortunately the tree has not a long life.

Distribution : A native of Sumatra and Java. Planted in the Peninsula, in Calcutta and Bombay, very likely elsewhere.

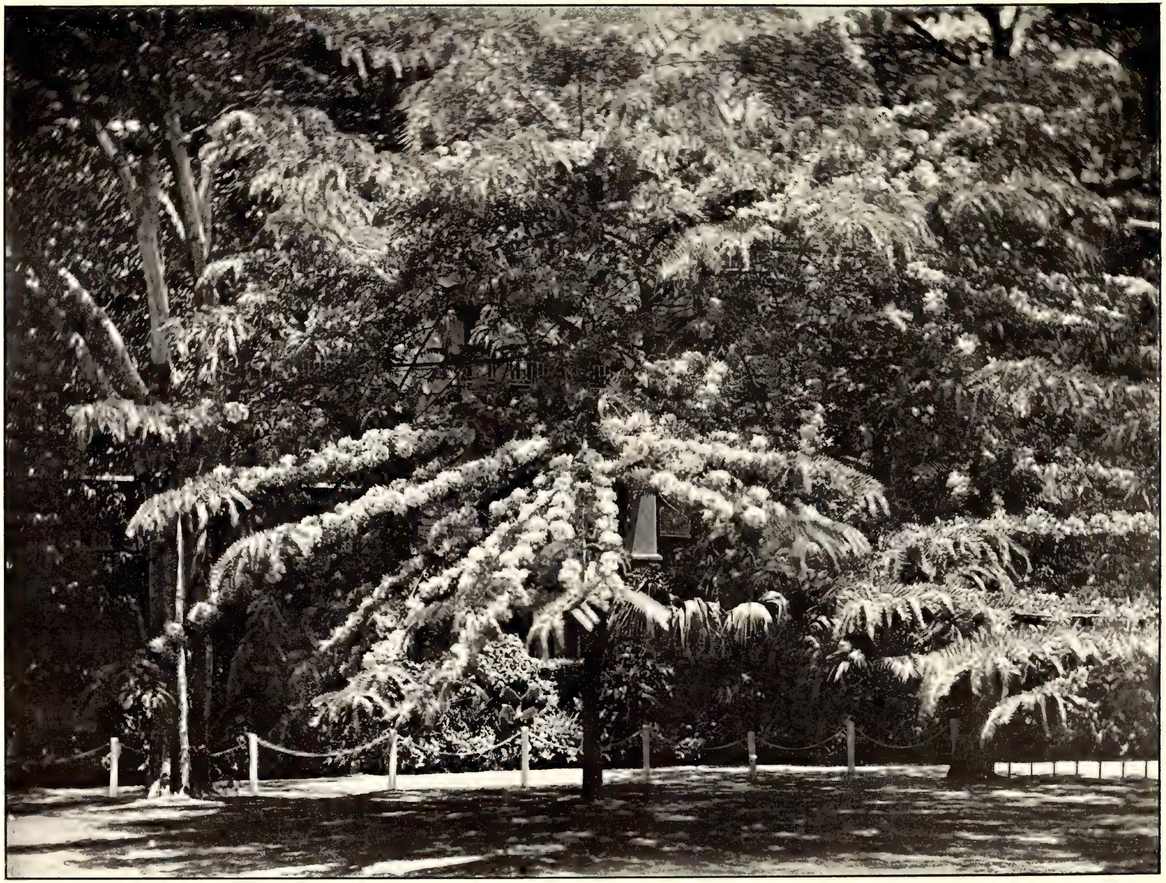
THE BUSUK-BUSUK.

Popular names : Busuk-Busuk, Turucop Bumi, Sibsuk (Malay Peninsula) ; Gnoo-thein (Burm.).

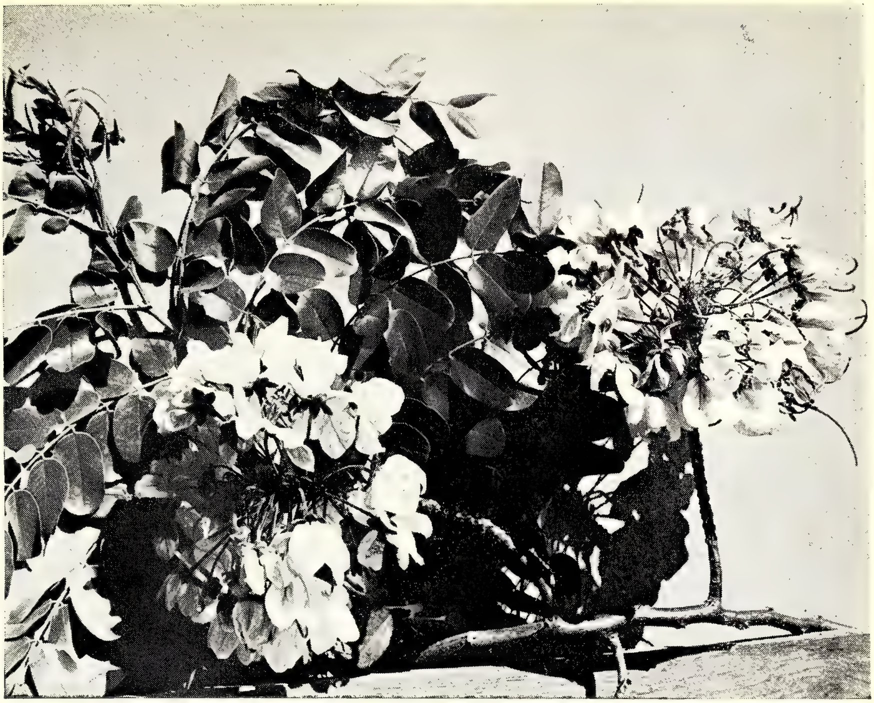
Cassia nodosa Ham. in Roxb. Hort. Beng. (1814) 31.

The term *nodosa* means a node. It alludes to a character in the 3 longer stamens of the flowers of this tree which are spherically thickened in the middle. The character is present in the flowers of some other species of the genus.

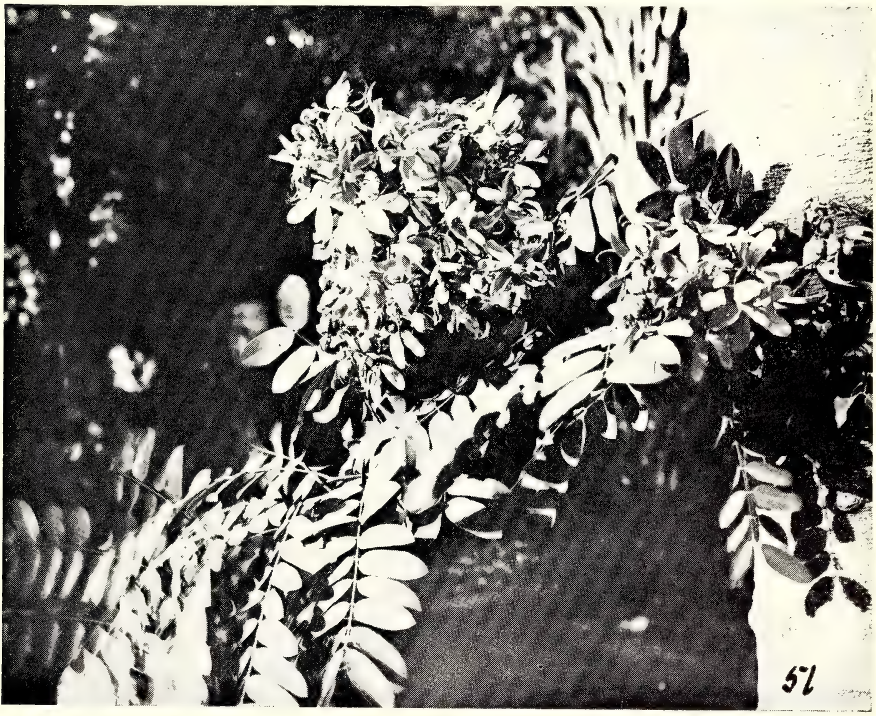
As this Cassia, in common with the Java Cassia, is frequently planted on roadsides and in gardens, we give here a description which emphasises the points of distinction between these two trees which are very similar in general habit.



The Java Cassia (*Cassia javanica*) trees in flower at the Royal Bombay Yacht Club.

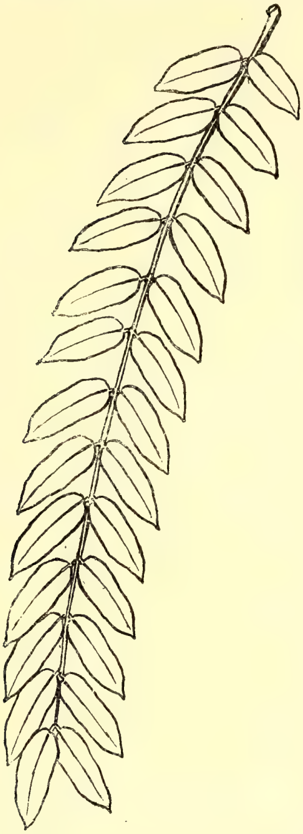


Flowers and leaves of *Cassia javanica,* Linn. Note the blunt tips of the leaflets.



Flowers and leaves of *Cassia nodosa,* Ham. The leaflets are more oblong and pointed than in *Cassia javanica.*

(*Photos by C. McCann*).



Cassia nodosa grows to a larger size than the Java Cassia. Like the Java Cassia, it has a crown of spreading branches with numerous drooping feathery-leafed branchlets. The leaf is about from 6 inches to a foot in length. It is composed of from 6 to 13 pairs of leaflets without an odd terminal leaflet. The base of the leaflet is oval but towards the apex it narrows and becomes almost lance-shaped. The leaflets of the Java Cassia are blunt or rounded at the tips. Another point of distinction is the texture of the leaflets. Those of the Java Cassia are glossless, slightly downy below. They have a silky feel. The leaflets of *C. nodosa*, when full grown, are smooth and leathery in texture with a glossy upper surface. Like the Java Cassia, the flowers come out in big distinct clusters. These clusters, grouped along the branches in pairs or solitary, grow from the axils of the leaves or more usually above the scars of the fallen ones. The flowers and buds are of the same bright pink colour and display the same tendency to fade white. They are set in whorls at the end of a short branchlet. The points of distinction are: The flower of *C. nodosa* has a velvety calyx with green sepals, in *C. javanica* the calyx is smooth and the under surface of the sepals is deep red; the petals of the former are more sharply pointed at the tips than in the Java Cassia; finally the leafy bracts at the base of the flower stalks are distinctly heart-shaped in *C. javanica* while in *nodosa* they are narrow and lance-shaped. The flowers have 10 very unequal stamens. The lower 3 are the longest, each with a distinctive globular swelling in the middle. These nodes in the middle of the stamens give the tree its name, but this character is also present in the flowers of *C. javanica* and in other Cassias. The pods are similar in both trees. Those of the Java Cassia are said to grow longer, reaching from 18 to 24 inches while the pods of *C. nodosa* are from 12 to 18 inches in length.

Flowering season: May and June.

Distribution: Burma, Chittagong, Malay Peninsula, China, Sumatra, Borneo.

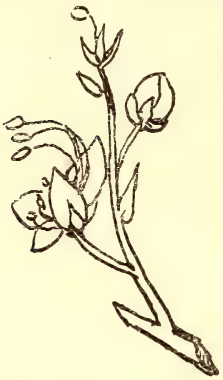
THE RED CASSIA.

Popular names: Red Cassia; Vakal (Tam.); Kada konna (Mal.).

Cassia marginata Roxb. Hort. Beng. (1814) 31.—*C. Roxburghii* DC.

Description: A rather small, round-shaped tree, growing about from 15 to 20 feet in height with slender, downward curving branches. Less robust in appearance than the Cassias previously described, the

Red Cassia is uncommonly beautiful at all times, particularly when in full flower. The leaf is composed of from 10 to 20 pairs of leaflets. They are leathery, smooth above and blunt at the tips. The flowers appear in small single clusters growing from the axils of the leaves, on the young twigs of the year. There is a great profusion of them covering the upper surfaces of the drooping branches. The petals of the flowers are terra cotta red with fine green veins, deeper in tone on the under surfaces. The older blooms are very bright pink. The 2 lower petals of the flower are usually the largest, though the flower itself is small, the petals not being more than half an inch in length. All the stamens bear anthers. The 3 upper-most are the longest, they protrude and curve inwards and are crowned with dark red anthers. They have no swelling in the middle as with the stamens of *C. nodosa* and some of the other species. In the centre there are 4 much smaller stamens with bright red anthers and 2 lower stamens. These 2 are the smallest. They bear yellow anthers. The sepals are salmon pink. There are pale green bracts at the base of the flower stalks. The pods are cylindrical, 8–12 inches long with transverse partitions.



Flowering season : The Red Cassia commences to flower in May though the height of the flowering season is June when the trees are smothered with their little red flowers. The seed pods are ripe in March and April.

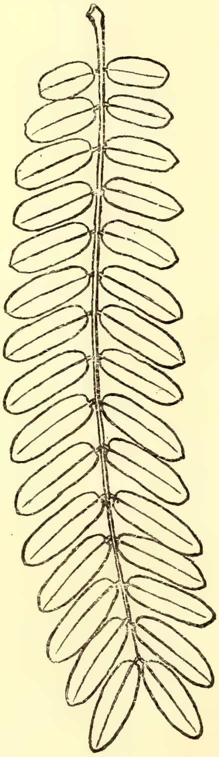
Distribution : The Red Cassia is a native of Ceylon. It was introduced in the Royal Botanic Gardens at Calcutta in 1802. It is a common tree in South India from South Arcot to Travancore and in the forests of Mysore and the Carnatic. It is not uncommon in Bombay gardens. There are a number of fine specimens in the grounds of St. George's Hospital originally planted by Lt.-Col. Dimmock.

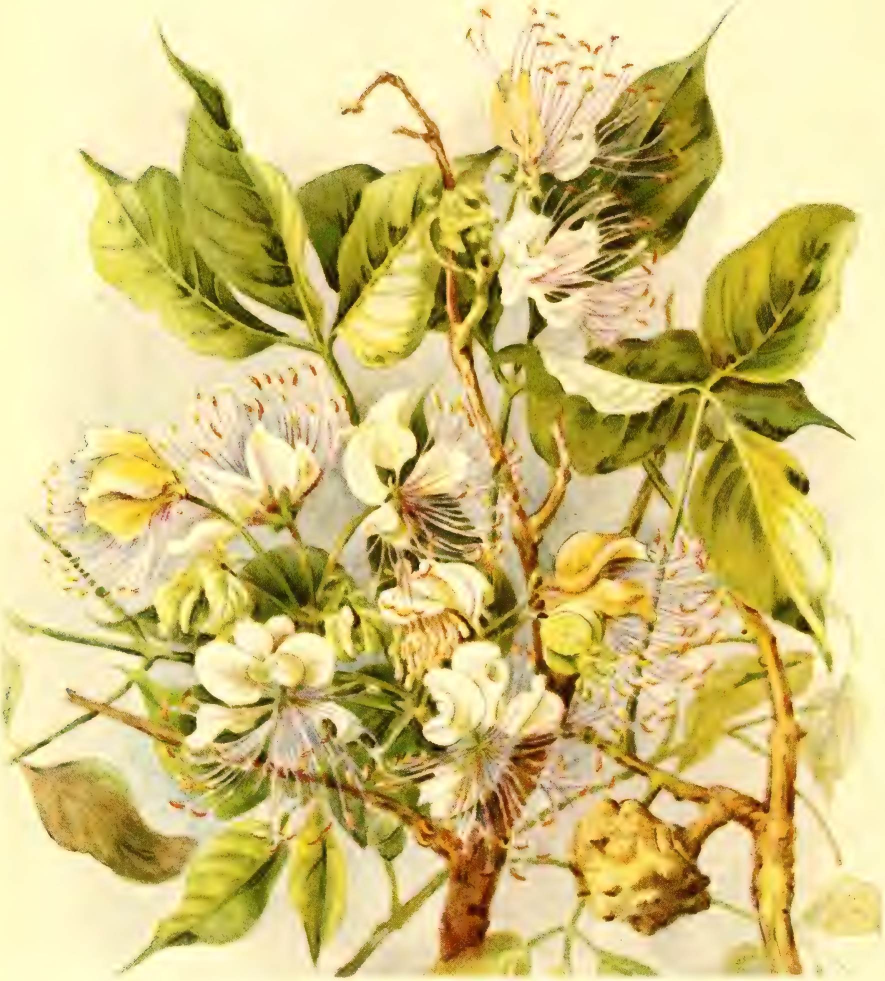
The Horse Cassia.

Popular names : Horse Cassia, Pink Shower

Cassia grandis Linn. f. Suppl. 230.

Description : The Horse Cassia is common in Bombay. It is a small tree with deep green foliage. The terminal leaflets on the younger leaves have a coppery tinge which is very distinctive. The leaves are velvety to the touch as they are finely hairy above and below. A leaf contains from 10 to 20 oblong leaflets abruptly rounded at both ends. The flowers are rose coloured ; they grow in the axils of the leaves in drooping racemes. There are no





John Bale, Sons & Danielsson, Ltd London.

THE SACRED BARNA.
Cratæva nurvala, Ham.
(½ nat. size)

bracts at the base of the flower stalks. The pod is 3 inches or less in length, compressed, cylindrical, smooth, and transversely wrinkled.

Flowering season : The Horse Cassia flowers in February and March when it has lost its foliage.

Distribution : A native of Tropical America; grown in many tropical countries.

Cassia multijuga Rich.

This is a small South American Cassia which was introduced into Bombay from Peradeniya, Ceylon. Its leaves contain from 20 to 25 pairs of oblong-elliptic leaflets, hence the name *multijuga* which means many pinnæ or leaflets. The leaflets are a bright green above and very pale, almost white below. The tree bears masses of bright yellow flowers during August and September when it is in full leaf. This is the latest flowering Cassia. The cycle commences with the flowering of the Horse Cassias in February and ends with this species in September.

We append here a key which will help in distinguishing the various species of Cassias we have described.

A. Bracts very small falling off long before the flowers appear.	
1. Leaflets few, large, smooth, in distant pairs.	*C. fistula.*
2. Leaflets many, hairy, in closely approximate pairs	*C. grandis.*
B. Bracts conspicuous persisting till the flowers open.	
a. Leaflets 6–14 pairs. Racemes lateral :	
1. Leaflets pointed at the tips ; smooth ...	*C. nodosa.*
2. Leaflets rounded at the tips, hairy below.	*C. javanica.*
b. Leaflets 8–20 pairs. Racemes growing from the scars of the fallen leaves ...	*C. renigera.*
c. Leaflets 10–20 pairs. Racemes growing in the axils of the leaves on the young twigs of the year	*C. marginata.*
d. Leaflets 20–25 pairs	*C. multijuga.*

THE SACRED BARNA.

Popular names : Barna, Barun, Bilasi, Bila, Biliana (Hind.), Barun, Tikto-shak (Beng.); Tailudu, Bunboronda (Mechi); Purbong (Lepcha); Barna, Barnahi (Pb., Raj.); Bela, Bel (C.P.); Vayavarna, Bhatavarna, Hadavarna, Kumla, Waruna, Karvan (Bomb.); Kumla, Karwan (Mar.); Maralingam, Marvilinga, Narvala (Tam.); Nirvala, Vitusi (Kan., Mal.); Uskia, Usiki Manu, Ulimidi, Urimidi, Urumitti, Tella ulimidi, Tellavule (Tel.); Nirujani (Coorg); Kadet, Katat (Burm.); Varuna, Asmarighna (Sans.); Roxburgh says that it is the Tikta-shaka of Sanskrit writers.

Crataeva Nurvala Ham. in Trans. Linn. Soc. XV (1827) 121.—*C. religiosa* [1] Forst. var. *Nurvala* Hook. f. & Th. in Hook. f. Fl. Brit.

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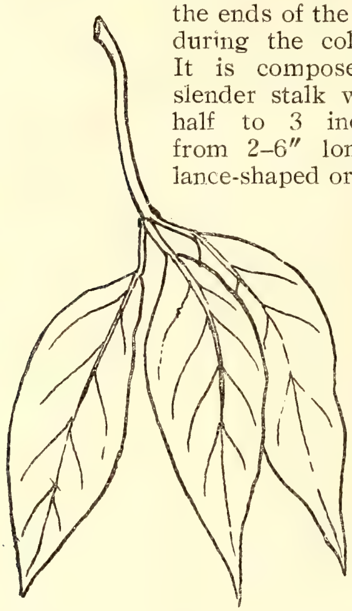
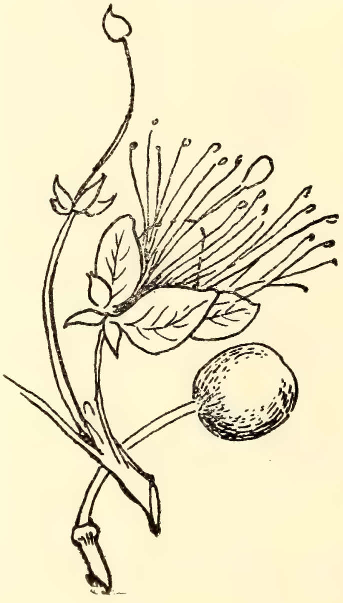
[1] Our plant has been known under the name of *C. religiosa* for a long time. This, however, is a Polynesian tree and totally different from the Indo-Malayan plant which has to be called *C. Nurvala* Ham.

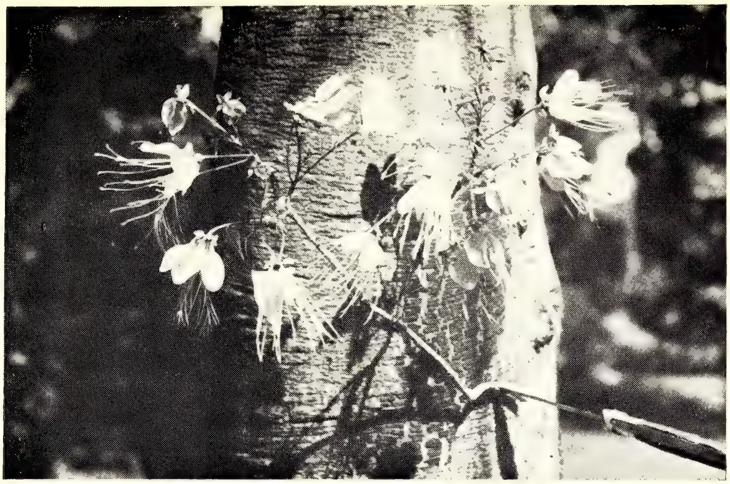
India I, 172. (*Capparidaceæ* or Caper. family). (*Cratæva* after Cratevas, an obscure writer on medicinal plants, not at the time of Hippocrates, but at the beginning of the first century B.C., since he named a plant after Mithridates. Nurvala is an Indian vernacular name.)



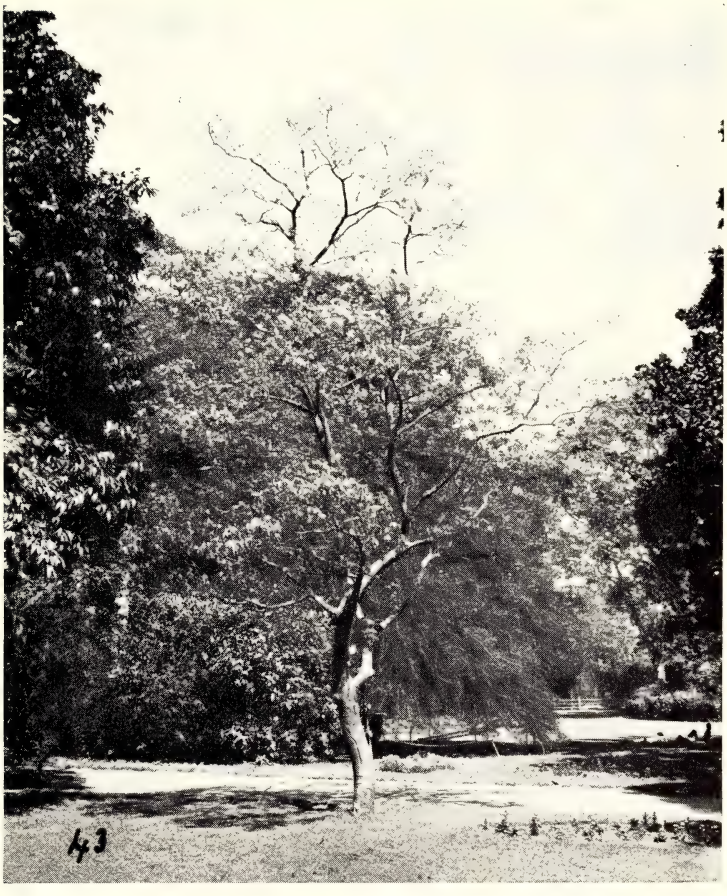
Description: The Sacred Barna is a small tree with a much branched head of glossy foliage; its leaves clustering mainly towards the ends of the branches. The tree sheds its leaves during the cold weather. The leaf is trifoliate. It is composed of 3 leaflets growing on a long slender stalk which may be from an inch and a half to 3 inches in length. The leaflets are from 2–6″ long. Their shape varies from oval to lance-shaped or they taper to a fine point. They are covered with a net work of veins, smooth on both surfaces, glossy above and pale, almost white below. The young leaves appear with or sometimes before the flowers. The tree is very handsome when profuse in bloom. The flowers grow in dense greenish-white clusters at the ends of the branches. Each cluster is borne upon a sturdy stalk. The sepals of the flower are small, oval and pointed at the apex. They are green when young; fading to pale pink or yellow. The white petals also fade to yellow. They measure 1 by $\frac{3}{8}$ inch. There is a very narrow claw petal $\frac{1}{4}$ inch in length. A bunch of long, thread-like spreading stamens protrude from the flower. They are much longer than the petals and purple or white when young, lilac when old. The Sacred Barna is one of a class of plants which is called gynophorous, which means that it bears its ovary at the end of a long stalk. The gynophore in the present species appears like a lilac thread 2 inches long with the swollen ovary at the tip. When the petals fall away the thread-like gynophore remains; it thickens and bears a globular woody fruit which contains numerous brown, nearly smooth seeds.



Distribution: Throughout most parts of India and Burma, wild or cultivated. Often found along streams, but sometimes occurs almost gregariously on dry, deep boulder formations in the



Flowers of the Sacred Barna (*Cratæva Nurvala*, Ham.).



The Sacred Barna (*Cratæva Nurvala*, Ham.)

(*Photos by C. McCann*).

sub-Himalayan tract from the Ravi eastwards. A favourite tree near temples and tombs. It is a common tree in Bombay where it is known as the 'Wai-warna'.

Leaf-shedding, Flowering and Fruiting: The tree is leafless in the cold season, the new leaves appearing in February and March. The handsome lax-clustered flowers, white, turning yellowish or pale pink, having numerous prominent stamens with purple filaments, appear in March-May (December-April in southern India?), and the fruit, a hard-rinded many seeded berry, 1–2 inches in diameter, ripens in the rains (about August in northern India). The seeds are about $\frac{1}{5}$ inch in diameter, somewhat compressed, helicoid-reniform or irregularly circular, dark brown; testa hard but splitting readily along a suture round the seed.

Gardening: Although often found in moist shady places the tree is more a light demander than a shade-bearer. It is partial to loose deep alluvial soil near streams, while its long taproot enables it to grow on deep boulder formations where water is at some depth. It is sensitive to frost, at all events in its early stages. It produces root-suckers freely.

Two conditions favourable for natural reproduction are bare ground and sufficient moisture. Seed scattered in grass or among weeds both on moist and on dry ground, or in dry situations on bare soil, persistently failed to germinate, while if scattered on moist bare ground it germinated both in the open and under dense shade, though in the latter case the shade soon killed off the seedlings.

Seed should be sown at the time of ripening, in the rains, on deep loose soil kept sufficiently watered, or in deep pots or boxes, and transplanted during the following rains. The seed may not germinate, even if kept regularly watered, until about May or June of the year after sowing, in which case the plants will be ready for transplanting about August or early September; they are then ordinarily about 3–6 inches high. Owing to the long taproot care is necessary in transplanting.

Uses: Wood yellowish white, when old, turning light brown, moderately hard, even-grained. Used for drums, models, writing-boards, combs, and in turnery. In Trichinopoly it is also used for making planks and as firewood.

Medical uses: The bark is demulcent, antipyretic, sedative, alterative, and tonic; and the fresh leaves and root-bark are rubefacient.

The bark is useful in some cases of urinary complaints and fever, and in some mild forms of skin diseases in which sarsaparilla is generally resorted to. It also relieves vomiting and other symptoms of gastric irritation. The fresh leaves and root-bark, particularly the former, are very efficacious in all the affections in which mustard poultice is indicated.

" Bruised well with a little vinegar, lime-juice or hot water and applied to the skin in the form of a poultice or paste, the fresh leaves of *C. religiosa* (*C. Nurvala*) act as a rubefacient and vesicant so efficiently that I do not hesitate in saying that they are not only much superior to the mustard seeds in this country, but also quite equal, if not superior, to the flour of that drug imported from Europe. From

5 to 10 or 15 minutes is the time required for them to produce their full effect as a rubefacient, and if kept longer than this in contact with the skin they begin to act as a vesicant. The existence of one or two plants of *C. religiosa* (*C. Nurvala*) in each Hospital and Dispensary will certainly save them from the cost of the supply of Europe mustard for external use.

" The fresh root-bark of this plant is also a very good rubefacient and vesicant, but it is rather too dear and not procurable in large quantities. The bark of the stem is very thick (from 1 to 2 inches when fresh, and from ½ to 1 inch when dry), greenish brown on the outer side, and grey or pale white internally and on the inner side, and almost tasteless and odourless. It is one of those barks which can easily be reduced to a coarse powder immediately after its removal from the stem ". (Moodeen Sheriff).

The bark of the stem and root of this plant constitute the principal medicine of the Hindoo Pharmacopœia for calculus affections. It is said to promote the appetite, decrease the secretion of the bile, act as laxative and remove disorders of the urinary organs.

In Bombay, the leaves are used as a remedy for swelling of the feet, and a burning sensation in the soles of the feet. The leaf-juice is given in rheumatism in the Konkan, in doses of ½ to 3 tolas, mixed with coconut juice and *Ghi*. In caries of the bones of the nose, the leaf is smoked and the smoke exhaled through the nose. The bark and the leaf pounded and tied in a cloth are used as a fomentation in rheumatism.

THE PIG-TAILED MACAQUES (*MACACA NEMESTRINA*).

BY

R. I. Pocock, F.R.S.

Temporary Assistant in the Zoological Department of the British Museum.

In his volume on the *Mammalia of British India*, pp. 18-21, Blanford described two species of these Macaques as members of the Fauna, the first, *Macacus leoninus*, inhabiting Arakan and Upper Burma, the second, *M. nemestrinus*, Tenasserim. But owing, in a measure, to lack of material, he seems to have had no first-hand knowledge of these monkeys and his descriptions of them contain many errors due to a variety of causes into which it is needless to inquire.[1]

The typical Pig-tailed Macaque (*M. nemestrina*), which is common in the animal trade and is a familiar exhibit in most menageries, is found in Borneo, Sumatra and the Malay Peninsula, but does not extend so far north as Tenasserim; and since it is not known to occur in any part of British India, it is only incidentally concerned in the subject-matter of this paper. Great diversity of opinion exists with regard to the Pig-tails which replace it in Tenasserim, Siam and Burma; and much confusion over their names and characters has arisen mainly from erroneous identifications made more than half a century ago. These are explained in the following attempt to straighten the synonymy and define the races which appear to me to be distinguishable.

By way of preface it must be stated that I agree with Mr. Boden Kloss in thinking that all the different kinds of Pig-tails, ranging from Upper Burma to Borneo, that have been named and described, belong to one species, *Macaca nemestrina*, a name given by Linnæus in ? to an example from Sumatra.

Of the British Burmese Pig-tails the first to be described and named was *leoninus*. This name was given by Blyth in 1863 to an adult male sent to him with a young specimen from Northern

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[1] The skull, alleged by Blanford to be that of a very old ♀ of *M. nemestrina*, obtained by Bingham on the Thoungyeen River, Tenasserim, is the skull of a very old ♂ of the Stump-tailed Monkey, *M. speciosa*, which Blanford called *arctoides*; and the skull from Mergui, presented by Dr. Oldham to the British Museum, which Blanford also assigned to *M. nemestrina*, is the skull of an adult ♂ of the Crab-eating Monkey, *M. irus*, which Blanford called *cynomolgus*.

Arakan by Sir A. P. Phayre. The name *leoninus* was, however, inadmissible because it had been previously and very appropriately applied to the Travancore species, the so-called Wanderoo, *M. silenus*. Nevertheless, *leoninus* was used for this monkey by all writers on the Indian fauna until 1912, when Elliot set it aside and rightly substituted the inapplicable name *andamanensis*.

This name, *andamanensis,* was given in 1869 to a female Pig-tail received at the Zoological Gardens and stated to have come from Port Blair in the Andamans, its author, Bartlett, not unnaturally supposing the Andamans to be its natural home. But in the following year (*Proc. Zool. Soc.* 1870, p. 220), Capt. F. Hamilton wrote to say that there are no indigenous monkeys in those islands and that the specimen had been imported, with several others, some years previously from the adjoining mainland of Burma. He did not say whether it came from the northern or eastern mainland.[1] It might have come from either.

In 1906 two new names for British Burmese Pig-tails were introduced by Miller. One, *Macaca adusta,* was given to some specimens from Champang and Red Point in Tenasserim; the other, *M. insulana,* to examples from Chance Island in the Mergui Archipelago. To Miller belongs the credit of being the first author to show that the Tenasserim Pig-tail is quite distinct from the more southern form *nemestrina*.[2] But curiously enough his paper contains no reference to the extensive literature relating to *leoninus*.

Finally, in 1919 Boden Kloss gave the name *indochinensis* to some specimens from Klong Menao and Lat Bua Kao in Eastern Siam. In the same paper he stated that he had seen from Trang, in Peninsular Siam, two male specimens of the Pig-tail, of which one had all the characters of typical *nemestrina,* found at Selangore, Perak and other places in the Malay Peninsula, whereas the other approached in colour the Tenasserim form named *adusta* by Miller. From this he inferred that Trang indicated roughly the latitude where the northern and southern types of this monkey blend. Furthermore, he summarised his conclusions[3] regarding the races of Pig-tailed Macaques, based partly on Miller's paper and partly on his own observations, in a tabular key setting forth their differences. This I venture to abridge.

1. Muzzle elongated; back blackened ... *nemestrina.*
2. Muzzle modified, tapering; back only slightly blackened in the middle line; annulations of hair conspicuous and markedly present over a larger area of the body.

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[1] He spoke of the island of which Port Blair is the capital as "Ross Island". I cannot ascertain the authority for this, Ross Island being one of the Mergui group, where these monkeys are probably indigenous. His information regarding the monkey was extracted from a private letter and there has perhaps been some confusion about the locality of the specimen.

[2] It may be noted that the characters Blanford ascribed to the Tenasserim monkey were derived from this southern type.

[3] It is significant that he omitted to consider the form from Chance Island, Mergui, named *insulana* by Miller.

a. Shoulders bright russet [ex Miller] … … … … *adusta*.
b. Shoulders tinged with dull russet … … … … … *indochinensis*.
3. Muzzle much reduced and shortened, face more vertical; more annulations in the fur; mid-line of back scarcely blackened … … … … *andamanensis* (=*leonina*).

Setting aside *nemestrina* which is distinguished by its comparatively immense jaws, browner general colour, with a blackish back, and typically less conspicuously annulated hair, Kloss's analysis shows that the differences in coloration between *adusta, indochinensis* and *andamanensis* are comparatively trivial. For reasons given below, I consider them to be inconstant and of no systematic value. As regards the skull-characters by which Kloss separated *andamanensis* from *adusta* and *indochinensis,* they too have no value because they were derived from figures, published by Anderson, of a skull taken from a Pig-tailed Macaque, which, as stated below, is quite distinct in colouring from *andamanensis* as represented by Bartlett's type of that monkey and by Blyth's type of *leonina*. It was from an examination of the skin of the latter, in the Calcutta Museum, that Kloss drew up his description of the colours of *andamanensis*. This specimen was also seen and described by Anderson in 1881 and by Elliot in 1912. It is, indeed, abundantly clear from Blyth's original description of *leonina* that this male from Northern Arakan closely resembled the Tenasserim and Siamese forms described later as *adusta, insulana* and *indochinensis*.

The British Museum contains a good number of specimens of these British Burmese and Siamese Pig-tails, including the type of *andamanensis,* a co-type of *indochinensis,* as well as others from Eastern Siam, several from Tenasserim and the Mergui Islands, whence the types of *adusta* and *insulana,* came, and one from Upper Burma. No two of the skins are alike, even from the same locality, as the following account of them shows.

The type of *andamanensis,* which has never been properly described, is uniformly annulated from the crown, which is not darkened, over the shoulders to the middle of the back with ochraceous buff and blackish grey, giving a yellowish olive hue, rather brighter and yellower on the shoulders, where the hair is long and somewhat mane-like. On the hind-back and loins the annulations become more obscure, the pelage here being darker olive, a little intensified in the middle line. The upper side of the tail is black and contrasted with the back. The arms are olive grey outside and annulated to the hands. The legs outside are very much the same hue but without annulations. The sides of the forehead and cheeks are grey, with the tips of the full whiskers duskier and annulated. The under side of body and the inside of arms and legs are greyish white.

This specimen, as recorded above, came from Port Blair in the Andamans. But there is nothing in its coloration to preclude the idea that it is the female of the form described as *leoninus* by Blyth. It is not, however, quite like the male which Blyth described as having the crown infuscate, the general colour grizzled brown, the hairs being annulated dusky and fulvous, with the long mane on the shoulders strongly tinged with golden ferruginous, the middle of the back behind the shoulders darker and the tail black above with a reddish tip. This description was taken from the specimen when fresh; and since the type of *andamanensis* was presented to the British Museum in 1871 and not unstuffed and removed from the gallery till 1909, it is no doubt somewhat faded and duller in colour than when it was alive.

Anderson described an adult ♀ he shot just to the south of Bhamo in Upper Burma as resembling Blyth's type but without any darkening of the crown and with the tail yellowish brown. The only example I have seen from Upper Burma is a very old ♀ collected for the Mammal Survey by G. C. Shortridge at Hkamti in Upper Chindwin, 500′, on July 26. It is very different from the female described by Anderson, being much redder, although the two localities are alike in the valley of the Irawady and less than 250 miles apart. The general colour is a uniform buffish brown, redder in patches; the head is obscurely annulated but the rest of the pelage lacks the annulation characteristic of these Macaques. The coat, however, is long and shabby, suggesting the imminence of the moult which probably occurs in July, as it does in the common Rhesus Monkey (*M. mulatta*). This may account for the absence of annulation on the hairs of the body and their faintness on the head.

From Tenasserim, whence the specimens of *adusta* came, the British Museum has an adult ♂, shot in November, an adult ♀ and her young one, shot on December 29, and a half grown female, shot on December 13, all collected at Bankachon for the Survey by G. C. Shortridge.

In the adult male the crown is only slightly darker than the nape. The hairs of the upper side are everywhere annulated with yellowish buff and brown, their bases being yellowish on the shoulders, where they are longer, grey on the back. The general tint is rather rich yellowish brown on the fore part, greyer and more olive behind, with the middle line of the back darker and tinged with greyish black, passing into the blackness of the upper side of the tail. The buttocks are markedly grey and sharply contrasted with the duskier hue of the back. The arms outside are much greyer than the shoulders, with the hairs annulated with buffish grey to the hands. The leg is greyish brown and indistinctly annulated. The cheeks and temples are mostly grey, with the hairs of the whiskers apically annulated with fuscous. The throat, chest and inside of the limbs are also grey, but the fore part of the abdomen and the lower arm are speckled with annulations.

This specimen differs apparently from the type of *adusta* in lacking the bright russet hue of the neck, shoulders and fore-back, the blackness of the crown and the light ochraceous buff of the buttocks. But I regard these merely as individual differences; and this view is supported by the colour of the adult female from Bankachon, the hairs of which are annulated orange and grey, the orange predominating, the whole dorsal area, except the hind-back and loins, which are duller and darkened in the middle line, being very brightly coloured, russet. The arms below the elbows are greyer than the shoulders but annulated; the legs outside are greyish brown and only indistinctly annulated.

The half grown female from Bankachon is not nearly so "russet" as the adult, the annulations being yellower; but the arms are as bright and as annulated as the shoulders. The still younger specimen is tolerably well coloured, annulated buffish yellow and brown. The youngest of all, newly born, is pallid buffish grey, without annulations.

If we set aside the youngest specimen, which has not moulted its "baby" coat, the rest of the specimens from Bankachon attest considerable individual variation in colour in the same locality. A subadult ♂ from Sullivan's Island, Mergui Archipelago, collected for the Survey on February 31 by C. Primrose, is darker on the crown than the adult male from Bankachon and browner, not so bright on the nape and shoulders, but the buttocks are yellower and the arms exhibit brightish yellow annulation, almost lemon on the hands; the legs, both outside and inside are darker, and there is no annulation on the abdomen.

Before these Bankachon and Sullivan Island specimens are set aside, their likeness, or otherwise, to the specimens Miller described from localities near at hand in Tenasserim and the Mergui Archipelago, giving them full specific status as *Macaca adusta* and *Macaca insulana* respectively, must be considered. About *adusta* from Champang something has already been said; and since it must be presumed that the Bankachon specimens are representatives of the same race, their considerable variability in colour, both general and in detail, shows that no great reliance can be placed upon such characters as the difference between red yellow and buff or black, brown and dark annulations in the hairs, or even between the presence and absence of annulations in certain parts. The Chance Island specimens, according to Miller, differ from *adusta*, the mainland form, in having the hair on the shoulders noticeably longer than on the back, the chest and belly more heavily grizzled and the hands and the feet noticeably darker than the arms and legs. But since the male from Bankachon has the hair on the shoulders noticeably longer than on the back, this feature is not distinctive of the insular form. The example described above from Sullivan's Island differs in details from those from Chance Island and from the specimens from Champang and Bankachon on the mainland; but it does not differ more from the Bankachon specimens than they differ from each other. I cannot, indeed, find a single reliable character to distinguish these Tenasserim and Mergui Pig-tails from Blyth's Arakan specimen. By describing the shoulders of this specimen as "golden ferruginous", Blyth, I imagine, intended to convey the idea that they were the same colour that Miller assigned to *adusta*, namely "russet".

Precisely similar individual variations in colour are exhibited by the Siamese specimens in the British Museum.

An adult ♀ shot at Klong Menao in S.-E. Siam, in January, and assigned by C. B. Kloss to *indochinensis,* is greyish olive brown in general hue, with no bright yellow or red tint anywhere, the annulations, although traceable, being indistinct; the middle line of the back is slightly darkened and the hair below the buttocks is whitish.

Another adult ♀ from Klong Tundai, Tongha, December 21, is much brighter. The annulations are not sharply defined but the shoulders are bright ochraceous buff, there is more black pigment on the lumbar area, the whiskers are yellower, not so grey, the hair on the buttocks is buffy and the hands and fore-arm are clearly annulated pale greyish yellow. This specimen approaches in brightness of colour the adult ♀ from Bankachon but is not quite so russet and in poorer coat. Its coloration also recalls that of the ♀ from Hkamti in Upper Chindwin.

A female from Pak Jong in Eastern Siam (December 4), also assigned by Kloss to *indochinensis,* is brighter in tint than the female from Klong Menao, the shoulders and nape being comparatively rich ruddy yellowish buff with better defined annulations; the lumbar region and loins are darker, especially in the middle line, much as in the adult male from Bankachon and the buttocks are buffy. It is nearly intermediate in tint between the Klong Menao and Tongha specimens.

Finally, an adult male from Selok Poh in Panjang (January 22) is very like the Bankachon male but with more vivid annulations and more reddish yellow, ''russet'', on the shoulders, the lumbar region a little paler, the buttocks not so grey, more buffy, the whiskers whiter, with the tips of the hairs less pigmented.

Reference to Kloss's key to the races of *nemestrina* quoted above shows that he distinguished *indochinensis* from *adusta* by being duller russet on the shoulders; but, as the available specimens show, this difference of tint is of no systematic importance.

I have described these Burmese and Siamese Pig-tails in some detail to show the impossibility of dividing them into races by the characters employed by Miller and Kloss. If these characters are to be trusted the male and female from Bankachon are distinguishable forms. It is unnecessary to add anything further in justification of the following synonymy which embraces the names that have been applied to the Pig-tails ranging from Arakan and Upper Burma to Tenasserim and the adjoining districts of Siam.

THE PIG-TAILED MACAQUE OF BRITISH BURMA

Subsp. *andamanensis,* Bartlett.

Inuus nemestrinus (?) Blyth, *Journ. As. Soc. Bengal,* xiii, p. 473, 1844. Adult male (type) and young from North Arakan.

Inuus arctoides(?) Blyth, *Journ. As. Soc. Bengal,* xvi, p. 731, 1847. Alternative identification of the same specimen.

Macacus leoninus, Blyth, *Cat. Mamm. Mus. Asiat. Soc.,* p. 7, 1863. New name, but preoccupied, for the same specimens. Blyth, *Journ. As. Soc. Bengal,* xliv, p. 2, 1875 (*Inuus*). Anderson, *Cat. Mamm. Ind. Mus., Calc.* 1, p. 71, 1881. Description of Blyth's type.

Macacus andamanensis, Bartlett, *Land and Water,* viii, p. 57, 1869. Sclater, *Proc. Zool. Soc.* 1869, p. 467 (woodcut ♀). Elliot, *Rev. Primates,* ii, p. 208, 1912 (*Pithecus*). Description of Blyth's type of *leoninus.* Kloss, *Journ. Nat. Hist. Soc. Siam,* iii, pp. 343-344, 1919. Description of Blyth's type of *leoninus.*

Macaca adusta, Miller, *Proc. U.S. Nat. Mus.,* xxix, p. 559, 1906. Specimens from Tenasserim. Elliot, *Rev. Primates,* ii, p. 206, 1912 (*Pithecus*). Description of Miller's type.

Macaca insulana, Miller, *Proc. U.S. Nat. Mus.,* xxix, p. 560, 1906. Specimens from Chance Island, Mergui Archipelago. Elliot, *Rev. Primates,* ii, p. 207, 1912 (*Pithecus*). Description of Miller's type.

Macaca nemestrina indochinensis, Kloss, *Journ. Nat. Hist. Soc. Siam,* iii, p. 343, 1919. Specimens from Eastern Siam.

Locality of type: Port Blair, introduced from Burma.

Distribution: Arakan and Upper Burma to Tenasserim, including the Mergui Archipelago, and the adjoining districts of Siam.

Description: General colour comparatively pale with an individual tendency to erythrism, ranging from greyish olive to buffy yellow, russet or golden ferruginous, these tints being especially noticeable on the long hairs of the shoulders which are brighter than the back, the lumbar and sacral regions being duskier especially in the middle line but never so black as the upper side of the tail, the blackness of which is sharply contrasted. The hairs of the upper side typically profusely annulated with alternating pale bands of buff or yellow or russet and dark bands of brown or black, but their distinctness varies. The annulation is less conspicuous on the back and hind legs than on the shoulders and arms and may be quite inconspicuous, especially in the old coat. Crown the same colour as the neck or darker. Cheeks greyish or buffy, the hairs of the long fringe apically annulate to a varying degree. Under side greyish white with some darker annulations sometimes on the abdomen and inside of the limbs. Buttocks grey or buffy, sometimes indistinctly annulated, sometimes sharply contrasted with the back. Usually there is a whitish fringe projecting from the lower side of the base of the tail on each side.

This race differs from typical *nemestrina* in being paler and less brown in hue, in the absence of blackish brown unannulated hairs over the greater part of the lumbar and sacral regions which are noticeably paler than the upper side of the tail in the more profuse and widely distributed annulations of the hairs of the dorsal area and the paler crown.

The skull also differs in having weaker, less produced jaws, the elongation of the jaws and their greater expansion anteriorly in *nemestrina* being correlated with the larger size of the canine teeth of the males.

The weights and measurements of some specimens of this race of macaques and some dimensions of their skulls are included in the tables at the end of this paper.

Description of a New Race of Pig-tailed Macaque.

From the synonymy of the race just described I have excluded references to a Pig-tailed Macaque which since 1870 has been cited as *leoninus* or *andamanensis* and regarded as belonging to the same type of monkey as the male from Arakan Blyth described as *leoninus*. Blyth was partly responsible for this. When he visited the London Zoological Gardens in 1870, Sclater showed him a magnificent full grown male Pig-tail which had recently been received through the animal trade. Its locality was unknown; but Blyth at once pronounced it to be *leoninus*; and under that name it was entered. Sclater published a coloured plate of it by Wolf in the Proceedings of the Zoological Society, and declared it to be the male of the female Pig-tail which had been received the year before from Port Blair and named *andamanensis* by Bartlett. Blyth's and Sclater's identifications have been unreservedly accepted, although Blyth's hasty opinion was given without the possibility of close examination of the specimen or of comparison of it with his type of *leoninus* in Calcutta, and Sclater's view involved the conclusion that the sexes of this Macaque differ profoundly in colour, although in other species of the genus the males and females are alike in that respect. In addition to the figure of the very dark male above referred to, in the foreground, Wolf depicted the comparatively pale type of *andamanensis* in the background. Blanford reproduced, as a woodcut, the figure of the male to represent *Macacus leoninus;* and Elliot reproduced the whole plate in colour to illustrate the characters of his *Pithecus andamanensis*.

Neither of the monkeys in question lived more than a year or two in the Zoological Gardens and both when they died were luckily sent to the British Museum where they were examined independently by Anderson and Blanford. They are strikingly different; and the male differs equally strikingly from the Arakan male described by Blyth.

So far as I am aware, Anderson was the only author who saw and described as *leoninus* both these males; but he did not state that his description of 1898 was taken from the Zoological Society's specimen; nor when he described Blyth's type in 1881 did he comment on the marked differences, which can hardly have escaped him, between the two. No author but Kloss seems to have been puzzled by the discrepancies contained in Anderson's two accounts.

Needless to say, there is no evidence that the Zoological Society's specimen came from Arakan, although the skin is thus labelled. It may have done so; but it may equally well have come, as I suspect, from some other part of northern Burma or from north-eastern India. At all events, no specimen like it has been met with in Siam, the Malay Peninsula or the Sunda Islands where tolerably extensive collections of monkeys have been made. Only one other specimen resembling it has been described, namely, one stated by Elliot to have been living in the Calcutta Zoological Gardens at the time when he was compiling subject-matter for his Review of the Primates. It is a pity he did not ascertain on the spot the locality and history of this specimen; but he gave a description of it which applies very closely to the example recorded above.

The name I propose to give to this monkey and the bibliography relating to it are as follows:—

Subsp. *blythii*[1] nov.

Macacus leoninus, Sclater, *Proc. Zool. Soc.,* 1870, p. 663, pl. xxxv. Adult male, from unknown locality, exhibited in the Zoological Gardens, London, and identified by Blyth as his *leoninus.* Anderson, *Zool. Res. Yunnan.,* 1878, p. 52. Description of skin and skull of Zoological Society's specimen, which was sent to British Museum in 1872. Blanford, *Faun, Brit. India, Mamm.,* 1891, p. 18. Male specimen with fig. copied from Sclater. Not *leoninus* Blyth, 1863.

Pithecus andamanensis, Elliot, *Rev. Primates*, ii, 1912, p. 208. In part only, pl. of ♂, copied from Sclater and description of living specimen, from unstated locality, exhibited in Zoological Gardens, Calcutta.

Macaca nemestrina andamanensis, Kloss, *Journ. Nat. Hist. Soc. Siam,* iii, 1919, p. 344. Skull only, its characters taken from Anderson's fig. of skull of Zoological Society's specimen. Not *andamanensis* Bartlett, 1869.

Type.—The adult ♂ figured by Sclater in 1870. B.M. No. (?)

Distribution.—Unknown.

Description of type: General colour very dark, the hairs distinctly annulated everywhere except on the lumbar and sacral areas and parts of the lower side and of the limbs.

Crown mostly black, its hairs dark reddish brown at the base, broadly black at the tip. Hairs of the nape and shoulders long, especially of the shoulders and fore back, conspicuously annulated with orange red and black. On the lumbar and sacral regions the annulations disappear, the distal part of the hairs being black and their bases dark brown, at least over the lumbar region, towards the rump the bases become greyish white, but when the hairs are not disarranged these areas are mainly black, showing no contrast with the black tint of the tail. At the root of the tail on each side is a tuft of white hairs continuous with the shorter white hairs of its under side; the buttocks beneath the callosities are also white. Arms externally paler than the shoulders, the hairs conspicuously annulated black and buff to the hands; internally the hairs are pale brownish to the elbow, but annulated from the elbow to the wrist. Legs darkish olive externally, the hairs annulated yellowish and deep greyish brown; foot blackish brown, the hairs not annulated; inside of hind legs brownish on the thigh, dark greyish brown and indistinctly annulated below the knee. Cheeks mostly dusky grey, annulated with greyish buff, but the crest in front of the ear dark, the apical annulations black. Throat grey, the hairs with paler and darker annulations. Chest and fore part of abdomen conspicuously annulated with yellowish and dark grey; hinder part of abdomen brownish not annulated, like the inner side of the thighs and upper arm.

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[1] Named in honour of the distinguished zoologist, Edward Blyth, to whom so much of our knowledge of Indian Mammals was due.

In the blackish colouring of the crown and of the lumbar and sacral regions, the absence of annulations on the latter areas and the identity in tint between them and the upper side of the tail, this skin resembles typical *nemestrina*; but differs in the more profuse and conspicuous annulation of the nape and shoulders, the whiteness of the buttocks and of the fringe at the base of the tail, the grey hue and annulation of the hairs of the throat and chest and the generally darker under side.

It is strikingly different in its dark coloration from all the examples I assign to *andamanensis,* although resembling typical examples of that race in the annulation of the hairs of the shoulders, the white or whitish fringe at the base of the tail and a few other points.

Anderson figured and described the skull of this specimen and published many measurements of it in 1878; but did not give its history. The information he supplied regarding it was used by Kloss, in conjunction with the colour-characters of Blyth's type of *leoninus,* to differentiate *andamanensis* from *adusta* and *indochinensis.*

The skull is that of an exceedingly well developed and oldish specimen. It differs strikingly from adult skulls of typical *nemestrina* in the shortness of its jaws, comparatively small canine teeth, elevated, massive, wide brow-ridges, nearly vertical orbits, wide zygomata and mastoids, the coalescence of the temporal ridges over the parietals and uptilted occiput.

It is clearly more like the skulls of *andamanensis,* especially in the shortness of its jaws. I have only seen two male skulls of this race, one from Selok Poh in Eastern Siam, the other from Sullivan's Island, Mergui. Neither is quite fully developed; but both show certain likenesses to the skull of *blythii.* For example, in the Selok Poh skull the temporal ridges noticeably converge on the parietals where they are only 7 mm. apart as compared with 20 mm. on the frontals; but this skull has the depressed occipital plane, backwardly inclined orbits and low brow-ridges of typical *nemestrina.* The Sullivan Island skull, on the contrary, which is a little younger, has the orbits less inclined backwards and the occiput more uptilted. This skull, I imagine, might have acquired all the peculiarities of the skull of *blythii,* if the animal had lived another ten years or so under conditions favourable to its development. There is one other point. In the lower jaw of the skull of *blythii* the coronoid process and condyle are separated by a much narrower space than in any skulls of *nemestrina* or *andamanensis* I have seen. And it is necessary perhaps to add that the skull and skeleton of this monkey show no evidence of deterioration from captivity. The animal was evidently captured when full-grown, and it lived only a very short time in the London Gardens.

In the following table are recorded the weights and principal dimensions of examples of typical *nemestrina* and of *andamanensis* taken in the flesh. The only known example of *blythii* was not measured in the flesh; but Anderson, who probably measured the skeleton, gave the following dimensions: head and body 1 ft. 11 ins., tail 8 ins.; total 2 ft. 7 ins., practically the same as the male from Bankachon in the following table.

Locality and Sex	Head and Body	Tail	Total	Weight in lbs.	Name
Sarawak, Borneo, ♂ ad	2′ 0⅕″	9⅕″	2′ 9⅕″		*nemestrina.*
Tarussan Bay, Sumatra, ♂ ad.	1′ 11⅗″	8⅗″	2′ 8⅕″	30	,,
Kateman River, ,, ♂ ad.	1′ 9⅘″	7⅘″	2′ 5⅗″	27	,,
Perak, Malay Pen., ♂ ad	1′ 10⅗″	9″	2′ 7⅗″		,,
Selangor, ,, ,, ♂ ad.	1′ 10″	7⅗″	2′ 5⅗″	25	,,
Pahang, ,, ,, ♂ ad	1′ 9″	9⅕″	2′ 6⅕″		,,
Lat Bua Kao, E. Siam, ♂ ad	1′ 9″	10″	2′ 7″		*andamanensis*
Selok Poh, Panjang, ,,, ♂ ad.	1′ 10⅘″	6⅘″	2′ 5⅗″		,,
Champang, Tenasserim, ,,, ♂ ad	1′ 10⅕″	9⅕″	2′ 7⅖″		,,
Bankachon, ,, , ♂ ad.	1′ 11″	7⅗″	2′ 6⅗″	18	,,
Chance Island, Mergui, ♂ ad.	1′ 9⅖″	7⅖″	2′ 4⅘″		,,
Sullivan's Island, ,, , ♂ subad.	1′ 9″	7″	2′ 4″		,,
Tarussan Bay, Sumatra, ♀ ad	1′ 7⅗″	8⅖″	2′ 4″	16	*nemestrina.*
Tampanula River, ,, , ♀ ad.	1′ 7⅕″	8⅖″	2′ 3⅗	10·¾	,,
Tongha, E. Siam, ♀ ad.	1′ 5⅘″	7⅕″	2′ 1″	...	*andamanensis*
Bankachon, Tenasserim, ♀ ad.	1′ 7⅖″	5⅖″	2′ 0⅘″	10·¼	,,
Hkamti, Upper Chindwin, ♀ old	1′ 5⅘″	7⅕″	2′ 1″	...	,,

Notes on the table.—The adult male *nemestrina* from Sarawak was collected by the late H. C. Robinson at Sarabas. The examples from Sumatra were recorded by Miller and those from the Malay Peninsula and E. Siam by Messrs. Robinson and Kloss. The male from Lat Bua Kao is the type of *indochinensis*; those from Champang Tenasserim and Chance Island, Mergui, are respectively Miller's types of *adusta* and *insulana*. The other specimens were collected and measured for the Mammal Survey by G. C. Shortridge.

I have omitted from the table the dimensions of two females from Klong Menao and Pak Jong in Eastern Siam, assigned by Kloss to *indochinensis*, because the measurements on the labels, given in millimetres, indicate a size in excess of that of all the males recorded in the table. There was clearly some accidental error which I cannot explain.

The table shows close agreement in size between the two races, and that the tail is subject to greater variation than the head and body. Large females are not very much shorter than small males; but there is considerable difference in their respective weights.

Some skull-measurements of Pig-tailed Macaques :—

Locality and Sex	Total Length	Zygom. Width	Orb. Width	Max. Width	Upper Molars	1st Upper Molar	Upper Canine	Length of Lower Jaw	—
Sarawak, ♂ ad.	161	100	82	51	38	9 × 8	12	115	*nemestrina.*
,, ♂ yng.	133	82	63	44	37	9 × 9	10	92	,,
Pahang, ♂ ad.	151	100	83	55	40	10 × 9	11½	110	,,
Selangore, ♂ ad.	151	92	78	48	38	9 × 9	11	110	,,
Perak, ♂ ad.	144	90	72	48	37	9 × 8	10½	103	,,
Lat. Bua Kao, ♂ ad.	138	95	...	...	...	...	10	98	*andamanensis.*
Selok Poh, ♂ ad.	130	90	72	43	33	8 × 8	9−	93	,,
Champang, ♂ ad	136	94	...	...	...	...	...	100	,,
,, , ♂ ad.	130	88	...	...	...	...	...	94	,,
Chance Island, ♂ ad.	133	...	...	...	...	...	...	93	,,
,, ,, , ♂ ad.	128	...	...	...	...	...	...	97	,,
Sullivan's Island. ♂ subad.	122	84	69	41	32	8 × 8	9	91	,,
Loc. ? ♂ ad.	136	102	85	47	35	9 × 9	9	102	*blythii* (type).
Sumatra, ♀ ad.	134 +	84 −	...	...	...	...	..	93 +	*nemestrina*
"India", ♀ ad.	131	85	72	...	36	...	...	...	,,
♀ ad.	134 +	84 −	...	...	...	...	...	93 +	,,
Penang, ♀ juv.	110	73	63	...	...	...	...	76	,,
Klong Menao, ♀ ad.	117	76	64	39	32	8 × 7	...	...	*andamanensis.*
E. Siam, ♀ ad.	116	76	64	39	32	8 × 7½	...	80	,,
"Port Blair", ♀ ad.	115	76	64	39	34	8 × 8	...	80	,,
Pak Jong, ♀ ad.	114	76	64	40	33	8 × 8	...	81	,,
Bankachon, ♀ ad.	109	75	59	39	33	8 × 8	...	80	,,
Hkamti, ♀ old.	104	74	58	38	35	7 × 8	...	76	,,

Notes on the skull measurements.—The skulls have been arranged in approximately the same order as the skins to which they belong, the Sarawak specimen which heads the two tables being the largest Pig-tail known to me. I have inserted the dimensions of a young skull, with the last molars only just through the bone for comparison with the adult skulls of *andamanensis* which it closely resembles in length, although, be it noted, decidedly narrower. The canine tooth is not fully erupted.

Some measurements given by Miller of Sumatran specimens agree very closely with those from Pahang and Selangore, one being a little longer, namely, 154 mm. The measurements show that the skulls of adult *nemestrina* are on the average considerably longer and have larger teeth than those of *andamanensis*; but in details they vary a good deal from each other, as attested by the differences in width, especially of the muzzle, between the examples from Pahang and Selangore.

I am able, unfortunately, to give very few complete measurements of male skulls of *andamanensis,* and one of them from Sullivan Island, is not quite full sized. It may be noted that there is a complete overlap in size between the Champang and Chance Island specimens regarded by Miller as distinct species.

The measurements of the skull of *blythii* bear out what was said above with regard to some of its peculiarities. In total length it is exactly 25 mm., one inch, less than the adult male from Sarawak, but it is actually a little broader across the cheekbones (zygomata), the orbits and, it may be added, across the mastoids (the back of the skull behind the ears). It is almost exactly the same length as the skull from Champang in Tenasserim, the type of *adusta* Miller.

With regard to the female skulls very few measurements of typical *nemestrina* are available. Miller gives the length and breadth of two from Sumatra. The larger of these has been entered in the table; the other is a little smaller, namely, 130 by 82½ mm. The only adult female I have seen is ticketed "India". These three specimens show that females of this race are noticeably larger than females of *andamanensis*. This is borne out by the measurements of the young specimen from Penang, in which the first upper molar is only just through the bone, the second being still buried. Yet this example is about the size of the adult female from Bankachon. It is important to note that the dimensions of the skull of the type of *andamanensis,* labelled "Port Blair" in the table, are in almost punctilious agreement with Siamese skulls named *indochinensis*.

The only other skull which calls for comment is the small one from Hkamti in Upper Chindwin. This is a very old individual with the molars worn flat, the incisors dropped out and the jaws shrunken in length.

SUMMARY.

The views above stated regarding the distinguishable races of Pig-tailed Macaques (*Macaca nemestrina*) may be epitomised in the following analytical key:—

a. The back behind the shoulders at most slightly darkened, not nearly so dark as the top of the tail which offers a strong contrast; general colour much paler; jaws short ... *andamanensis.*

a'. The back behind the shoulders, and the crown, deep blackish brown, the same tint as the top of the tail which is not contrasted; general colour much darker.

b. Hair generally, except on the back, profusely annulated; colour not so brown; white tuft on base of tail and buttocks white, contrasted with the loins; jaws short; brow-ridge massive, orbits nearly vertical, occiput uptilted ... ... *blythii.*

b'. Hair generally comparatively inconspicuously annulated; colour browner, base of tail and buttocks not white and strongly contrasted with loins; jaws long, brow-ridge low, orbits sloping, occiput depressed ... *nemestrina.*

A specimen of the Pig-tailed Macaque, which must for the present be regarded merely as a variety or mutant of *M. nemestrina nemestrina,* was captured, it was alleged, many years ago at Long Salai on the Baram River, E. Sarawak, and after living in captivity for about five years was given by the Rajah to Major F. Day who brought it alive to England where it died in 1893. Its skin was exhibited to the Zoological Society (*P.Z.S.*, 1893, p. 325), by Mr. Sclater and was presented to the British Museum by Major F. Day.

Its general colour, to which Mr. Sclater drew attention, is a golden brown on the upper side, rather darker in the middle of the back, the hairs being uniformly tinted and without annulations. Nowhere is there any black. But the skin exhibits a variation, unnoticed by Sclater, which is unique in *M. nemestrina.* The hair on the middle of the top of the head grows straight backwards from just behind the brow where there is a short fringe of erect hairs. The head thus lacks the definite cap of hair radiating from a whorl near the centre of the crown which is found in *M. nemestrina.* The hairs on the cheek, however, are directed upwards to the sides of the crown as in that monkey. The hair-growth on the head, indeed, partakes of the characters of the two species *M. mulatta* and *M. nemestrina*; and despite the story of the capture of the specimen as a wild animal, I am inclined to regard it as a menagerie-bred hybrid between those species, an opinion supported by the colour. At all events examples of *M. nemestrina*, from the Sarawak district, which I have seen are perfectly normal in colour and hair-growth on the crown. Hence the coincidence of two ''mulattine'' characters, namely, erythrism and backward hair-sweep on the crown, would be surprising in a wild specimen. Nevertheless, the skull, which is just adult, does not, I admit, look like the skull of a monkey reared from birth to maturity in captivity, unless, of course, more favourable conditions are supplied in Borneo than England. It only shows a little of the characteristic menagerie scowl and prognathism.

THE STUDY OF INDIAN BIRDS.

BY

HUGH WHISTLER, F.Z.S., M.B.O.U.

PART VIII.

(*With a plate*).

(*Continued from page 103 of this volume.*)

THE REPRODUCTION OF BIRDS.

The Nest.

However ignorant people may be of Nature and her ways there is practically no one who is ignorant of the fact that birds make nests. It is one of the most conspicuous and widely known of all the attributes of bird life. Just as the egg is one of the salient characteristics of a bird, known alike to savage and civilized man, so too is the construction of a nest to hold that egg, a corollary which is known to all. In this chapter therefore I propose to discuss some of the facts connected with birds' nests and some of the angles from which they may be considered.

We have already seen that the egg is one of the reptilian features which a bird retains from its ancestral heritage. The nest, on the other hand, may be regarded perhaps as one of the mile-stones that mark the rise of the bird above its ancestry.

On broad lines most of us are familiar with the reptile's treatment of its eggs. The snake deposits the grape-like cluster in a rotting manure-heap or in any secret hole or corner. The lizard's eggs are found within a crevice in a wall. The crocodile and turtle bury their eggs in holes in the sand. The actual site in all cases is doubtless determined largely by chance, influenced by the fairly obvious if unconscious idea of concealment. Occasionally the site may add slightly to the process of incubation. The natural generation of heat in decaying vegetation or the sun scorching the sands must have some influence on the buried eggs. In rare cases the parent guards the eggs, her presence doubtless retarding the loss of heat even if it does not serve to generate it.

But in every class of reptile the care for the egg is almost the minimum, probably much as it was amongst the great reptiles of the primeval world whom we may picture as depositing their eggs in the decaying bogs and leafmould of their sweltering world and then and there forgetting them.

But, with the slow development of the bird from the reptile, this treatment grew inadequate. As the temperature of the bird rose and it became warm-blooded, the egg must have become less automatic in its development. A higher temperature was required for the maturing of its vital germ. The call on the parent was greater and as the parent responded to the call methods, obvious and instinctive in their beginning but with the seeds of rapid improvement within them, soon suggested themselves by which the parent could help in incubation and, in the process, add to its own safety, comfort and ease. To pull a little rubbish into a hole is an instinctive matter but it contained the germ of an idea capable of much improvement. And as the bird became gradually an arboreal creature, *pari passu* with its growing wings, it gradually shunned the dangers of the ground and the hole in which it might so easily be trapped by its non-flying relatives and enemies. The hollow and the hole on the tree trunk or the cliff face was more favoured than the ground, and the provision of the artificial hollow naturally followed.

To-day we may still see in actual use all the stages between the most primitive methods of bestowing the eggs in or under the surface of the earth side by side with the most wonderful forms of artificial nest and I propose to make a brief review of all these stages. But there is one proviso of which to warn the reader in advance. The line of development has not been either continuous or in equal measure with the evolution of the different orders of birds. The same ideas have originated in different classes. They have advanced sometimes on the same lines, sometimes on different lines. There have been sudden steps and limitations, due to the chances of environment or fate; and sometimes no doubt there have been retrogressions, sudden returns to primitive methods. The result is that the stages we shall observe have no connection with the degrees of the physical development of the birds that employ them. The fallacy must be avoided of comparing the sketchy dove's nest with the crow's far better structure and drawing from the evolution of the nest a guide to the evolution of the families. The furthest that it is safe to go in this respect, is to state that Passerine birds, as an order the most highly developed of all birds, reach the highest levels of nest architecture; or we may see and note the evolution of a particular type of nest, such as the saliva-gummed nest of the Swifts, running through the family, and reaching its highest point of success in particular species, so long as we do not attempt to correlate it with the evolution of the various members of the family.

The primary purpose of a nest is to be a receptacle for the eggs. It is in its essence and construction nothing more. Without the eggs it is meaningless to the bird. In practice it often serves to hold the young after they have left the egg. In practice it may add a little to the process of incubation, to the comfort of the incubating bird. Occasionally it is used as a shelter, and very occasionally dummy or extra nests are built as part of the normal routine of a bird's reproductive circle. But viewed in wide terms, the sole aim and function of a nest is to contain the egg.

One is tempted to believe that the most primitive nest in the world is that of the Megapodes, of which one species *Megapodius nicobariensis* is found in the Andamans and Nicobars. Although in a sense—viewed from the standpoint of human intelligence—the nesting arrangements of this bird appear somewhat elaborate, I regard it as primitive in its resemblance to that of many reptiles.

The megapode of our area lives and nests just within the dense tropical jungle that clothes the island shores at spring tide high water mark. Here in the jungle the birds collect great mounds of decaying vegetation and sandy soil. These mounds vary in size. A small one may be three feet high and twelve or fourteen feet in circumference; an average one five feet high and thirty feet in circumference. An exceptionally large one is recorded as eight feet high and sixty in circumference. Hume's account is worth quoting:—'It appears to me that the birds first collected a heap of leaves, coconuts and other vegetable matter, and then scraped together sand which they threw over the heap, so as not only to fill up all interstices, but to cover everything with about a foot of pure sand. I say *sand,* but this term is calculated to mislead, because it does not contain much silex, but consists mainly of triturated coral and shells. After a certain period, whether yearly or not I cannot of course say, the birds scrape away the covering sandlayer from about the upper three-fourths of the mound, cover the whole of it over again with vegetable matter, and then cover it over again with the sand.' The general effect is much that of a leafmould heap as prepared by any gardener. In such a heap, the bird or birds—for there is some doubt as to the number of females which use a given mound, place their eggs which hatch therein without any assistance apparently from the female. It is generally assumed that the heat generated by the decaying vegetation causes incubation. The young are hatched in a very advanced stage, feathered and able to fly, apparently extricating themselves unaided from the mound.

The similarity of this system to that of many reptiles is self-evident, except in so far as the formation of the mound is concerned. Davison indeed tells us that reptiles often use the megapode mounds and that he himself from one mound besides megapode eggs dug a dozen eggs of some large lizard.

It would be interesting to know the blood temperature of megapodes as compared with other birds. For the eggs are evidently hatched by the mere retention of the body heat with which they are laid, conserved by the superincumbent sand and vegetation; and one might hazard a guess that the megapode has still an approach to the lower reptilian temperature which finds such conditions all that is necessary for incubation. The eggs are reported to be abnormally tough in constitution. St. John records how some eggs taken were put away and forgotten, left exposed to the open air and rain and still about half of them hatched. But it must be remembered that in tropical climates air-heat is sufficient to complete the incubation of well-advanced eggs of widely differing species. All egg-collectors in India have had the experience of hard-set eggs hatching on their tables, sometimes several days after taking. In the hot, moist, primeval jungles incubation must have been far more of a spontaneous development than it is in the cooling world of to-day.

Incubation by the parent bird must have been a process long in development, marking slowly the rise of the bird from its reptilian, cold-blooded ancestry and the slow dessication and cooling of its surroundings. Parental interest in the egg meant parental presence in the nest. The act of laying insensibly merged into the act of incubation. Increase the importance of an object and more attention is paid to its receptacle. The cared-for and carefully-tended egg was provided with a nest. It was one of the mile-stones to mark the progress of the evolution from the reptile to the bird.

Originally, one may presume, all eggs were placed in holes in the ground or amongst stones and rocks. White—under which term I include all dingy varieties of that colour—is the colour of all reptile's eggs, which have reached the stage of a hard shell. It is therefore doubtless the original colour and we find it to-day still amongst the vast majority of birds which lay their eggs in holes. In a hole hidden from the gaze of passing creatures the conspicuous nature of white is of no importance. Evolution has not needed to work upon it and the primitive condition remains. Eggs which are laid on the ground in the open, on the other hand, are usually well-coloured, often in patterns and colours that tend to obliterate them amongst their surroundings. The variety and the success of such patterns makes it evident that evolution has been at work in their case. For this reason one decides that the placing of the egg in a hole is a far more primitive condition than the placing of an egg on the ground.

To my mind the nesting of the Storm Petrel (*Procellaria pelagica*) is very instructive as an illustration of the supposed ancestral method of nesting. It is fresh in my mind as I saw it recently in the Mediterranean.

We landed on a tiny islet, little more than an outcrop of stone on which time and wind had collected a mixture of soil and stones with a few creeping plants. A Herring Gull standing on a rock was the only living thing in sight, save for a few scuttling lizards and the familiar snails of the Mediterranean seaboard. The gull had no nest and there was nothing else apparently to breed there. I walked round about the island and could see nothing of interest. Then I tried the sense of smell, like any other mammal. I sniffed round the crannies of rock and the piled-up heaps of stones until a sickly oily smell rewarded my search, the unmistakable smell of Petrel. Had I been a fox or a jackal, my search would still have availed me nothing. The rough stones would have foiled my digging paws. But human hands can go where other mammals fail. I lifted out a number of large stones until finally in a crevice a Storm Petrel was visible brooding the solitary egg. There proved to be a large colony of the birds packed into the crevices of the stones and rock, some brooding eggs, others waiting for the eggs to come, all drowsing away the hours of daylight.

On that islet, man was probably the only enemy that ever could rob the colony. With altered details the scene was typical of the nesting habits of many of the Petrel family and it is evident that the isolation of the sea has preserved amongst them a picture of the original method of the nesting of birds before evolution changed their habits.

There must have been variations on this habit of nesting under stones and amongst a chaos of fallen rocks. For such sites are not found everywhere, and in the great primeval swamps and forests they must have been often lacking. So parallel with such sites we may consider a habit of pushing in amongst herbage, fresh or decayed, for concealment and the scraping of hollows in sand or loose deposits. The nesting on the ground amongst herbage is such an obvious method that we need not labour it here. The habit has continued amongst innumerable species and we find it at the present day practised still by birds with nests in every degree of evolution.

But the scraping of holes merits rather more attention. Here again we may find it profitable to consider first the case of islet nesting species.

In this connection British Ornithologists would immediately think of the case of the Puffin (*Fratercula arctica*) whose burrows honeycomb the soil in all directions so that, on the islands where they breed it is almost impossible to walk across the turf without breaking through the crust. But for Indian Ornithologists the most handy illustration is found in the case of the Crab-Plover (*Dromas ardeola*).

To quote Mr. Stuart Baker:—'Sir Percy Cox and Major Cheeseman found immense colonies of these curious birds breeding on some of the islands in the north of the Persian Gulf, those on Buna Island consisting of several hundreds of birds. The eggs are either laid at the bottom of burrows in the sandy soil—in some cases apparently dug out by the birds themselves—or they are laid in hollows amongst the loose boulders and rocks. It undoubtedly, however, prefers burrows wherever the soil is sandy and loose enough for these to be made. They are of no great depth, being anything between a foot and four feet, the extremity where the nest is being rather larger than the entrance. Only one egg is laid but that one is enormous in size compared to the bird. In colour it is a pure white, with a very smooth close texture, but not particularly hard or glossy, whilst in shape it is a long oval, slightly pointed at the smaller end . . . the birds are said to sit very close and have in some cases to be pulled out of the hollows which they refuse to quit.'

When we remember that the Crab-Plover is so primitive a species that systematists have difficulty in fixing its true affinities and position, when we regard its curious egg, I feel sure that we are entitled to regard this picture of its nesting as typical of very primitive conditions.

The principal of the burrow in the ground or in the face of a bank is not capable of much development, other than that of mere length. For some reason or other—possibly the fact that burrows are easily discovered by snakes and small predaceous mammals and that discovery often implies the entrapping of the bird upon her eggs—this mode of nesting is comparatively rare except amongst island-nesting seabirds; and those species that adopt it are often colonial in their habits.

India has a large share of the comparatively uncommon burrow nests. The Pied Kingfisher (*Ceryle rudis leucomelanura*) will immediately occur as an example of the isolated burrow. Whilst some of the various Bee-eaters (*Merops*), the Sandmartins (*Riparia riparia*) and the Bank Mynahs (*Acridotheres ginginianus*) furnish familiar instances of colonies of burrows. The longest burrows are probably those of the Blue-tailed Bee-eaters (*Merops javanicus*); in these 7 feet is no unusual length. The Bank Mynah colonies are remarkable for the amount of inter-communication often found between various burrows. Although burrows of these types are usually driven into bank faces, some of the Bee-eaters burrow into the ground. The labour involved is shown by the wearing down of the beaks of Kingfishers and Bee-eaters and this renders all the more remarkable the burrowing of the Sandmartins whose tiny beaks are ill adapted to the task. It will be noted that in such instances the building of definite nests within the burrows is confined to Passerine birds as a rule.

Starting with the assumption that the hole is the obvious form of nest, one is prepared to believe that becoming arboreal the bird readily adopted the chance of nesting in the natural holes and hollows that growth and decay soon provide in any tree. In such holes the ancestral white of the eggs would still be retained without modification. There is some significance doubtless in the fact that the birds which lay white eggs in holes with little or no nest mostly belong to the more ancient orders. When Passerine birds breed in holes, one generally finds that the hole contains a more or less definite nest and that the eggs follow the general colour-pattern of their group. This would seem to indicate that hole-nesting amongst the Passeres is not an original but a reversional trait.

The habit of nesting in a hole in a tree lends itself to two lines of development, obvious and circumscribed though they may be. The first is excavation. The second is masonry.

Suitable holes are not always numerous, especially in young and healthy trees. The would-be tenant, therefore, disappointed of the perfect hole of his desires, naturally falls into the way of clearing out the rotted wood which has not yet quite decomposed; he gnaws the entrance hole a little larger; he attacks even the circumscribing sound wood. Finally we reach the stage of the Woodpecker which drives a perfect burrow into hard wood, just as the Bee-eater drives it into earth. But the harder material implies more drastic specialization of structure, and that the Woodpecker family exhibits.

The opposite line of development is far rarer. Only a few species have attained the mason's craft which obviously means something more like reasoning power. Two outstanding Indian examples of this immediately occur to the mind, the cases of the Nuthatches (*Sittidæ*) and of the Hornbills (*Bucerotidæ*). As is well known, both of these families are accustomed to plaster up the entrance holes of their nest, though on somewhat different lines.

The simpler case is that of the Nuthatches. They adopt any hole in a tree, or occasionally wall, and as the entrance is usually rather larger than their requirements, they build it up with earth and clay, which dries to the consistency of plaster, leaving only a small hole just sufficient to allow of their passage. It is, however, to be remembered that a certain number of the family, usually known as the Rock Nuthatches, represented in Baluchistan, are accustomed to build a complete oven-shaped nest of mud on the face of cliffs, and it is possible that the nesting habits of the tree-building Nuthatches are really a retrogression, the plastering up of the holes being a relic of former habits. It is often manifestly unnecessary.

The case of the Hornbills is far more interesting. Hornbills are large birds, some of them very large. They nest in large holes in trunks and branches and the females are imprisoned in the holes, built in with a hard wall which leaves merely a wide vertical slit through which the sitting bird's beak can pass to receive food from the male who fends entirely for her during her captivity. The plaster in this case is apparently provided by the female's own excrement and she is believed to build it up herself from within. Here the motive appears to be solely defence and one must surmise that the habit has been rendered necessary by the large size of the birds and the consequent size of the entrance hole needed. This must render the bird vulnerable to the attacks of the larger arboreal mammals, monkeys and large squirrels, which, while able to attack the sitting bird in a large unprotected hole, must surely hesitate to tear at a small loophole defended easily by the Hornbill's great beak.

Hitherto we have dealt with developments of nests in which the site was all important. Such nest holes are really independent of any constructional skill. The presence or absence of any material in the nest is really negligible. With the abandonment of the hole the full scope of evolution begins.

A complete book might be written on the subject of Indian nests alone. Here I must be content with simply recording a few of the interesting developments which occur when once the nest is freed from the trammels of the ancestral hole.

For the moment we will concentrate on the arboreal nest.

It is easy to see how the arboreal nest originated. There must have come a point in the evolution of the arboreal lizard-bird where the supply of nest holes up in trees did not equal the demand. Failing in her search for a suitable hole the breeding female was compelled—under the urgent, unconscious knowledge that her eggs were ready for laying—to accept the best substitute available, the crown of a treefern or the hollow between the branches of a tree at the spot where they leave the trunk. In such a spot to-day one may find the nest of a Tree-Duck (*Dendrocygna*) which has been disappointed of a hollow bough. Some such hollows are very suitable, others are uneven or incomplete but with the piling in of a little material can be made to serve. In such hollows rubbish accumulates, and the very dullest instinct can soon learn to shuffle the rubbish into convenient positions and add a little to it to make things more satisfactory.

I saw an example of such a case not long ago. A pair of Wood-Owls (*Strix*) were living in a tract of wooded country where careful forestry had removed all dead and dying trees. There was literally no hole in the place which provided their usual requirements. They had in consequence perforce nested in a junction of the boughs of a large tree, where a small hollow, eked out with a few roughly-placed sticks afforded a nesting place for the eggs. The eggs were safe but when the young hatched and began to move about, their number dwindled, as chick after chick fell overboard.

Such must have been the position. Safety was for those with the greatest skill in adapting the available hollows and fencing in their sides with material to save the young from falling out. The young of the successful builders survived and evolution worked to perfect their skill. With advancing skill the choice of sites increased. Materials piled into a fork of a bough prepared a site, where had been none.

We can see this process at work any day. The ordinary cup-nest of the open Babbler-type is started by the haphazard piling of a collection of sticks, roots, fibres and grass into a convenient fork or tangle of twigs. The material is brought and dumped with no particular arrangement. Some falls to the ground. The rest catches in the twigs and accumulates, each successful piece making it progressively easy for the next piece to rest there. When there is a little pile the bird stands on it, shuffles it about, pokes ends in here and there, smoothes and rounds it by squatting down and turning about. In a short time there is the semblance of a nest. Finer materials are brought to line the cup, piled in haphazard and then smoothed into place and the structure is complete. The history of such a nest is the history of the evolution of the nest.

If a census could be taken of all the nests of all the species in the world it would certainly be found that the overwhelming majority are of this type—an open cup in which the foundations are of coarser material, growing progressively finer to the surface on which rest the eggs.

With this universal type as a starting point there are a number of modifications which for the most part, however beautiful and diverse their special characteristics, fall into well-defined types. The impelling purpose behind these modifications is always the same, the attempt to secure the maximum of safety for the eggs. Though there may be in addition, occasionally, the purpose of allowing a species to colonise a peculiar type of habitat which would otherwise not be available to it.

We must first of all in our consideration of these points avoid the common error of estimating all modifications in the light of their success as a protection against human enemies. It is so easy to say that the nest of a minivet (*Pericrocotus*) mimics an excrescence of the bough on which it is placed or that the nest of a White-browed Fantail-Flycatcher (*Rhipidura aureola*) looks like that of a hornet. These effects may be only in human eyes, viewed from the standpoint of the ground. Yet, as I emphasised under the question of protective colouration, the human enemy is under the normal conditions of Nature the most negligible of all. The various nest types were fixed long before man counted as an enemy. Now it is true man and his civilisation is a serious enemy but his influence works in other ways, without affecting established patterns.

This is no doubt the reason why birds appear so seldom to utilise protective sites other than holes. One is tempted to think that all wise birds would nest in the centre of cactus hedges, or beds of nettles, on the tips of Euphorbia plants, or at maximum heights in trees, forgetting that although these sites are deterrent to human beings they avail nothing against the real enemies of eggs and young. There are exceptions of course. The little nest of the Rufous-fronted Wren-Warbler (*Franklinia buchanani*) no doubt benefits from its habitual site in the matted thorns of the wild caper bush and the woodpeckers of the genus *Micropterum*, which nest in the centre of ant colonies, no doubt are protected by their involuntary hosts. But as a general rule protection of this type is valueless as the enemy can attack by the same road used by the owner of the nest.

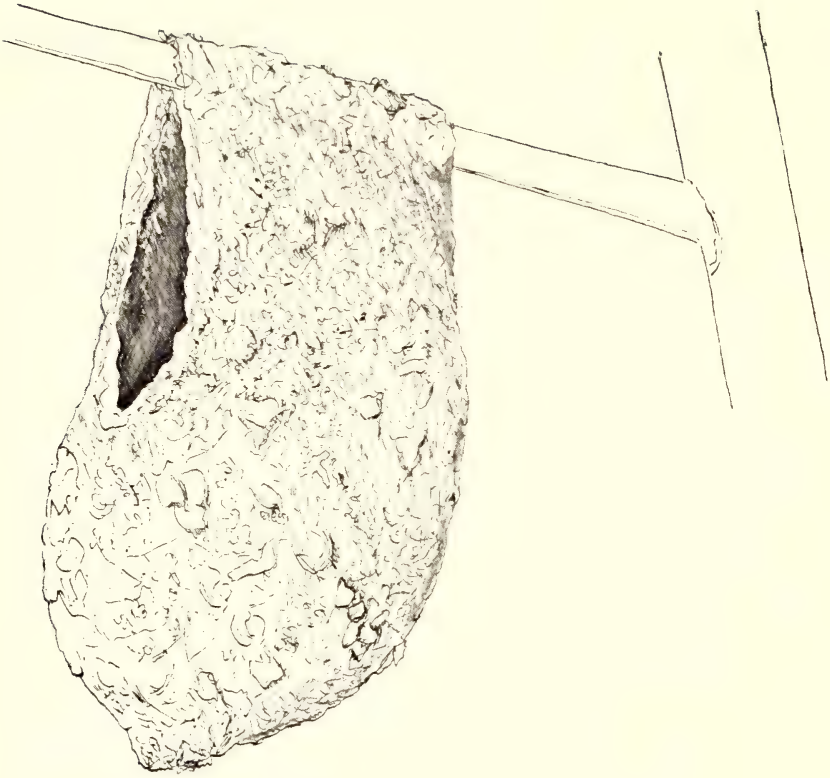
Leaving aside the most destructive of all enemies—the elements, birds chiefly require to protect their eggs against two classes of enemy, other birds and mammals and reptiles. Against birds the best protection is concealment; against mammals and reptiles this can be reinforced by difficulty of access.

The egg and chick-eating bird, of which the Indian Tree-Pie (*Dendrocitta vagabunda*) is a most familiar example, hunts entirely by sight. It probably has not even the reasoning power to watch deliberately a pair of birds to their nest. It wanders casually through the trees and bushes collecting a miscellany of food, finding what its keen eye lights upon. From below or sideways it may or may not recognise a nest—but certainly the eggs are most in danger at the angles from which they are visible. Invisibility is clearly the best protection and in the absence of the sitting bird this is best attained either by the doming over of the nest or by the obliterative colouration of the eggs.

Colouration and pattern are certainly far more of a protection for eggs and young than they are for adult birds. In ground-nesting species this is self-evident. In other cases one must not expect the eggs to match the nest when viewed in the open at close quarters. The effect to be appreciated is that of the nest and eggs viewed through a vista of boughs and leaves and glancing lights and shades. From such an aspect even the white eggs of a dove, on their sketchy light-admitting platform, fade away in the patterns of Nature.

The climbing mammal and reptile can be more easily foiled by placing the nest in situations where they are less likely to reach. Such an effect is attained by the Orioles (*Oriolus*) and the King Crows (*Dicrurus*) which build at the ends of the side-boughs of trees and the Shrike-Tits (*Pteruthius erythronotus*) which build on the topmost twigs of high trees. But such situations in turn render the eggs more liable to damage from the wind and the nests are therefore modified into the well-known hammock-type to give safety as the boughs sway. A similar safety from the wind is attained by the depth of the cup-nest of the Great Reed-Warbler (*Acrocephalus stentoreus brunnescens*), slung amongst the stems of the reedbeds which bend over at an angle of 45 degrees when the wind blows. Though here the situation of the nest is chosen not so much as a protection from enemies as to allow the birds to colonise a habitat for which there is little competition.

Protection from climbing enemies is also attained by the method



The Pendant Nest of the Thick-billed Flower-pecker—*Piprisoma squalidum.*
Nurpur 2,000 ft. C/3 eggs, 15th April, 1921.

of suspending the nest beneath a bough and most effectively from the tip of it. To secure the effect of suspension a considerable modification of structure is necessary and is attained by starting the nest in the form of a pendant loop of material, gradually filled in from the sides. This postulates considerable skill even for species like the common Purple Honeysucker (*Cinnyris asiatica*) which only use ordinary building materials. It does not seem surprising therefore that species which have attained the art of suspending their nests have also special skill in the use of unusual materials. This development reaches its apogee in the wonderful felt nests of the Flower-peckers (*Dicæum*) and the strong grass-woven nests of the Weavers (*Ploceus*). One can hardly envisage a more wonderful nest than that of the Baya (*Ploceus philippinus*); it is suspended by a cord from the tip of a palm leaf or thorny bough, and the inaccessibility of the site is reinforced by the close weaving of the tough grass strips (torn specially by the bird to suit its requirements), the long pendant entrance tube and the peculiar position of the egg chamber.

The reality of the protection afforded by these modifications of site is shown by their prevalence in tropical countries and their rarity in temperate countries where the enemies that inspire them are scarcer.

Compared with such nests, the far-more famous and advertised nests of the Tailor-birds (*Orthotomus*) and of certain Wren-Warblers (*Prinia* and *Franklinia*) are less wonderful. One or more leaves are linked together with threads and, in the cavity so formed, an ordinary cup-nest is suspended. The so-called 'sewing' of the leaves has attracted popular notice but the constructive skill involved is really far less than in numberless other nests.

This point—appeal to the imaginative faculties of the human mind—must be given its proper value in assessing the comparative development of different types of nest. The use of a given type of material may necessarily lead to a certain type of treatment with the result that a nest is produced which appeals to the human imagination, though it may be far less developed or wonderful in reality than structures which we accept without comment.

A case in point is that of the mud-nest of the Flamingoes (*Phœnicopterus*). This is a very simple structure, a little mound of mud moulded roughly in the shape of a cup-nest and baked by the action of the sun. It is the sort of nest which forms a simple solution of the difficulty of breeding on half-submerged mud-flats where alterations in the water level are apt to occur. Scrape up a heap of mud in such a place and pat it well into shape and firmness and immediately a little island is formed. The solution and the nest are amongst the simplest. Yet such a nest has been unduly advertised first of all because of a prevalent belief at one time that the long legs of the Flamingo could only be accommodated by a high clay cone which the bird straddled as if on a saddle, and secondly because, in 1912, a libel action was fought in the King's Bench Division, connected with Abel Chapman's and Col. Willoughby Verner's writings on the subject.

It is customary to consider the laying of eggs on the open ground as a primitive arrangement. With this I am quite unable to agree. I started by showing the primitive treatment of the eggs is undoubtedly that of concealment within the ground, whether in a mass of decaying matter like reptiles and megapodes or in crevices and burrows. The nest and egg only emerged into the open with development. And here we must keep in mind two separate lines of development. The nest and eggs of certain of the Willow-Warblers (*Phylloscopus*) are placed on the ground merely as a variant of the tree and bush sites adopted by others of the family. They have undergone no separate modification in connection with their ground building. The eggs and nests agree with those of the non-ground building forms, taking with them the same chances of concealment and discovery. In some species indeed the ground site and the bush or tree site are alternative. In some families such as the Wagtails and Pipits (*Motacillidæ*) the ground feeding habits of the species have made the ground nest almost universal, but neither nests nor eggs show any modifications which necessarily limit them to a site on the ground.

In birds like the Plovers (*Charadriidæ*) on the other hand the ground site is accompanied by the most substantial modifications and developments which cut them off entirely from the first case. Take the case of that familiar Indian bird, Jerdon's Little Ringed Plover (*Charadrius dubius jerdoni*). The three or four eggs are laid on a bed of shingle or sand and so closely resemble the stones around them that they are discovered by the eye—human or avian—with the utmost difficulty. The nest is a natural hollow in the shingle or a scrape in the sand, and if any material at all is used in its construction, the material chosen is small pebbles and pieces of dry clay which further the plan of concealment. It is useless to contend—as is sometimes done—that this is the primitive nest, the scrape in the ground from which all other nests have started. As much development has taken place between the white reptile egg in its hidden site and the Little Ringed Plover's egg on the shingle as between the original starting point and the elaborate structure of the Baya (*Ploceus philippinus*),—other needs, other modifications. Safety has been obtained on the one hand by elaborate construction and difficulty of access, on the other hand by increasing the difficulties of search. The Kentish Plover (*Charadrius alexandrinus*) indeed goes a step further than the Little Ringed Plover in concealment. Its eggs and nesting habits are similar except that it usually nests on sand, and this sand it heaps up over the eggs until they are almost buried from sight.

It is in the eggs and young of these ground-breeding species that the most acceptable examples of protective colouration may be found; and their importance is enhanced by the fact that totally unrelated forms have reached independently the same degree of development. The perfection of the Little Ringed Plover's nesting habits is paralleled by the case of the Sandgrouse (*Pterocletes*) and the Nightjars (*Caprimulgidæ*), totally unrelated forms and it is obvious that all have attained the same result by independent progress on a parallel line as the result of identical needs.

And here I may emphasise once more the fact that development of nesting habits has no connection with physical evolution. The Nightjars have no connection with the Sandgrouse though both lay eggs, similar in peculiar shape and colouration; while both rely for protection on the blending of the eggs, with the ground on which they are laid without a nest. Whilst amongst the Nightjar's nearest relatives are the Humming birds (*Trochilidæ*), which construct ordinary cup-nests of the prevalent type, and the Swifts (*Micropes*) which make most specialised nests. There is no need for me to describe the nesting of the Swifts here, as I have recently in the *Journal* (xxxiv, 772-777) discussed some of their peculiar methods. But I may emphasise that in the Swifts we find a very unusual degree of special development.

In all the types of nest which have been described above, and indeed practically in all nests, the materials used are collected by the birds from extraneous sources. The Swifts have the peculiarity that in the breeding season their salivary glands are enlarged to provide a glutinous substance, hardening with contact of the air, which is used largely in the construction of the nests. In the genus *Collocallia* the nest is made entirely of this saliva.

There is one other way in which birds provide their own nesting material. This is by plucking feathers and down from their own plumage. It is not common and is chiefly confined to the family of the ducks and geese (*Anatidæ*) amongst which it is general.

But though we may find down and feathers used in the construction of innumerable nests we will practically always find that the feathers were not provided from its own body by the owner of the nest. They were picked up loose and derelict, part of the World's rubbish like most of the materials of most nests.

There is no need for me to give a catalogue of the types of nest or a description of various very remarkable nests which are to be found in India. Such details may be taken from various books which describe the nesting of Indian birds, or culled from the bird-nesting experience of the reader. My aim has been merely to suggest the lines of evolution to which are probably due the infinite variety of form and fashion. But before closing the chapter I must add a few words on a question that sooner or later occurs to all—how does a bird learn to make its nest?

Now one thing is definitely certain that the architecture of a bird's nest is specific. A Little Ringed Plover breeding in one part of India will build the same nest as another Little Ringed Plover in a different part of India, perhaps a thousand miles away. A common Babbler's nest in the Punjab is exactly the same as a nest of the same species in Salem District. There will be a small limit of variation of course both in materials and construction; there will be the occasional freak nest; while occasionally we notice a species for which two or three types of nest are specific. The Ashy-Wren-Warbler (*Prinia socialis*) for instance may build a circular domed nest in a bush, or it may sew two leaves together and build a cup-nest within the resulting cavity, either type being normal for the species, if not perhaps for the same individual.

But within this reasonable amount of latitude we can lay it down as an established law that all birds' nests remain true to their specific type. This fact defeats all explanations as to how a bird learns to make its nest. A pair of birds start to breed in their first season. There is no hesitation how to set about the matter; there is no doubt of success, except from other factors; there is no system of trial and error resulting occasionally in the building of a nest proper to some other species. But the young pair immediately set to and build the nest of their species complete in all essentials, with no one teaching them how to do it. So far no one has been able to explain this ability. Various suggestions have been put forward, that the birds remember the nest within which they were born and therefore reproduce the same details; that young birds see the older individuals of their species building and copy their activities; that birds act from an inherited instinct which orders their work without their volition; or that nest-building is as much a psychological response to the physiological aspects of the breeding season as is the act of coition. There are objections to each theory. At present we can no more explain how a bird learns to build its own particular type of nest than say why the Indian Robin (*Saxicoloides fulicata*) invariably finishes off its nest with a piece of Snake's slough.

INDIAN DRAGONFLIES.

BY

F. C. FRASER, LT.-COL., I.M.S., F.E.S.

Part XXXVIII.

(*With two plates and a text-figure*).

(*Continued from page 76 of Volume XXXV*).

Sub-family : PLATYSTICTINÆ. (*Continued*).

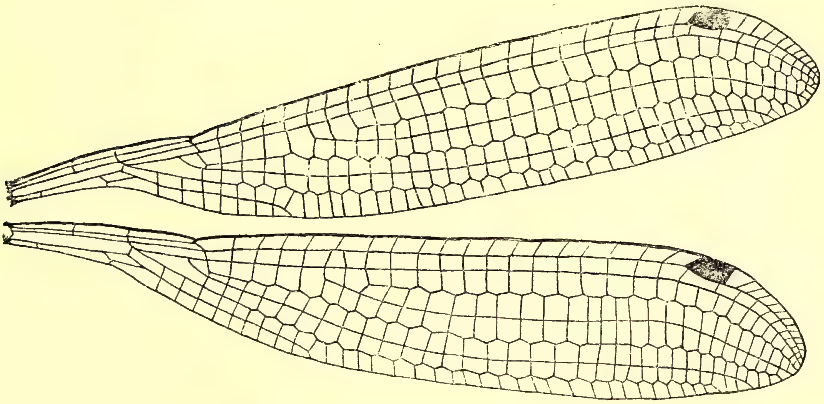


FIG. 1. Wings of *Platysticta deccanensis*, Laid.

Genus : PLATYSTICTA Selys (1860).

Platysticta Selys, Bull. Acad. Belg. (2), x. p. 436 (1860) ; Id. (Subgenus *Platysticta*, 1st group) Mem. Cour. xxxviii, p. 150 (1886) ; Id. Syn. Agr. sep. pp. 5, 6, 8 and 9 (1860) ; Kirby, Cat. Odon. p. 132 (1890) ; Laid. Rec. Ind. Mus. vol. xiii, pp. 339, 340 (1917) ; Id. *Spolia Zeylanica*, vol. xii, p. 360 (1924) ; Fraser, Legion *Platysticta*, Rec. Ind. Mus. vol. xxvi, p. 498 (1924) ; Laid. Journ. Malay branch, Roy. Asia. Soc. vii. pp. 303-304 (1924).

Dragonflies of slender build with the characteristics of the sub-family, of rather larger stature than the Protostictas but resembling them closely otherwise. Body-colouring non-metallic, black, brown or bright brick-red marked with azure blue. Wings closed when at rest, long narrow, falcate at apex, with a long petiole, hyaline or opaque at apices; discoidal cell elongate, costal border about four times as long as the proximal and slightly longer than the posterior ; sectors of arc arising at lower part of arc *but diverging form origin* ; an accessory basalpostcostal nervure always present near base of wing in addition to the nervure *Ac* which is situated about midway between the two antenodal nervures ; *Ab* always present but incomplete, meeting *Ac* at or well away from the posterior margin of wing and extending to the posterior side of discoidal cell which it meets at a point near its middle ; *IA* absent ; *Cuii* of about 6 to 9 cells in length ; *MA* and *IRiii* zigzagged almost from origins ; *Riv + v* arising a short distance proximad to the oblique nervure descending from the subnode, *IRiii* slightly proximad to the level of the subnode ; pterostigma subquadrate, costal side shorter than posterior which is somewhat convex, inner border oblique, unbraced, outer straight ; cells of wings mainly pentagonal.

Head, thorax and abdomen similar to *Protosticta* but *the latter less than double the length of wings* ; anal appendages variable, superiors forcipate, spatulate at apices ; inferiors usually shorter than superiors, broad at base, tapering to the apex which is acute or obtuse, directed straight back or curled inwards towards its fellow. Genitalia,—hamules broad quadrate plates, penis with apex curled strongly over dorsum and its branches long, curled and embracing the stem of organ ; a crest or ruff on the dorsum which simulates a spine as viewed in profile ; lobe flask-shaped. Vulvar scales very robust, minutely spined below, usually extending beyond end of abdomen. Larvæ unknown. Genotype.—*Platysticta maculata* Selys.

Distribution.—South India and Ceylon only. Three species only are included in this genus from within our limits and it is doubtful if other species outside of this area can be strictly classed as congeneric to *P. maculata.* Two species are from Ceylon, the third from Cochin in South India. The genus as defined here includes only those species which fall within the Selysian subgenus *Platysticta*, group 1. Like *Protosticta*, species of the genus are to be found along the banks of montane streams clinging to mosses and ferns overhanging shady spots.

Key to the species of genus *Platysticta*.

1. { Wings of male tipped with black ... ... *P. apicalis* Kirby.
   Wings hyaline throughout ... ... 2.
2. { Thorax uniform brick-red ... ... *P. deccanensis* Laid.
   Thorax black marked with blue ... ... *P. maculata* Selys.

The authorship of species *P. maculata* and *C. hilaris* has been shown as Selys, since Hagen's papers published in the Verhandlungen der k.-k. zool-bot Gesellschaft Wien, vols. viii and ix of 1858 and 1859 respectively gave only a list of names without descriptions. The descriptions of these two species were published later by Selys who adopted Dr. Hagen's names. It is even possible that the descriptions were communicated to Selys by Hagen as in the case of many others.

Platysticta maculata Selys.

Disparoneura maculata Hagen, Verhandl. zool.-bott-Gesell. Wien. vol. ix. p. 206 (1959).

Platysticta maculata Selys, Bull. Acad. Belg. (2) x. p. 437 (1860) ; Id. Rev. Syn. Agr. sep. p. 151 (1886) ; Kirby. Cat. Odon. p. 132 (1890) ; Id. Journ. Linn. Soc. (Zool) xxiv. p. 561 (1893) : Laid. Rec. Ind. Mus. vol. xiii, p 341 (1917) ; Id. ibid. vol. xi, p. 387 (1915) ; Id. *Spolia Zeylanica*, vol. xii, p. 361 (1924).

Platysticta greeni Kirby, Proc. Zool. Soc. Lond. p. 204, pl. xx. figs 3, 3a (1891).

Male. Abdomen 47–48 mm. Hindwing 31–33 mm.

Head velvety black ; labium brown paling to dirty white at base ; labrum glossy black, pale azure blue for its basal half ; anteclypeus pale azure blue as also bases of mandibles adjacent to it ; postclypeus and rest of head unmarked ; eyes black above, dark olivaceous brown below.

Prothorax black, its sides low down palest blue.

Thorax velvety black on dorsum as far lateral as the anterior border of metepimeron and traversed on each side midway between the humeral and postero-lateral sutures by a narrow pale blue oblique stripe. The hinder three-fourths of metepimeron palest blue changing to creamy white beneath thorax.

Legs brown, trochanters and coxæ creamy white, the base and flexor surface of femora pale, spines pale golden yellow.

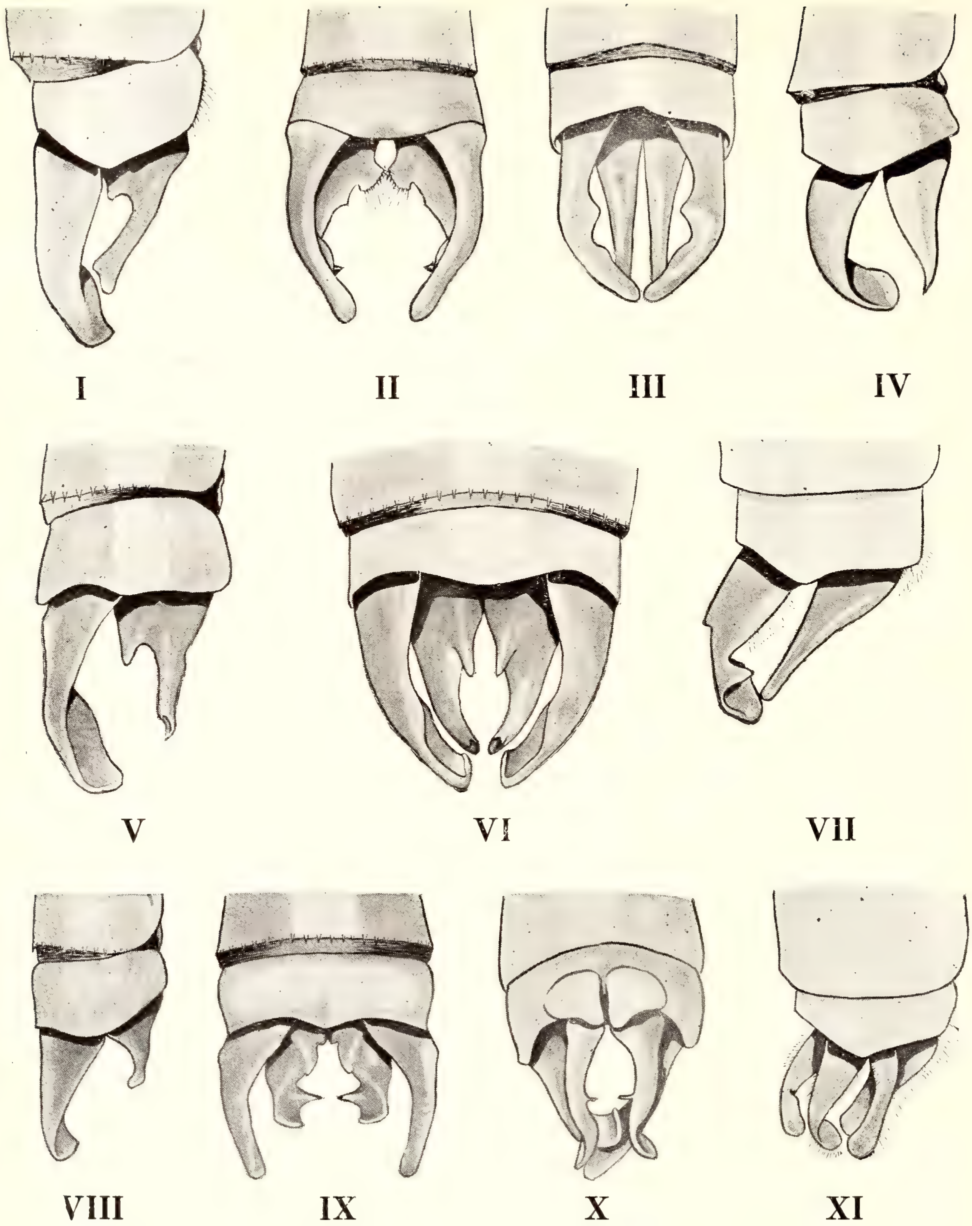


Plate I.

I. Anal appendages of *Ceylonosticta tropica* (Selys), seen from the right side.
II. The same, dorsal view.
III. Anal appendages of *Platysticta deccanensis* Laid., dorsal view.
IV. The same of *Drepanosticta annandalei* Fras., seen from the right side.
V. Anal appendages of *Platysticta apicalis* Kirby, seen from the right side.
VI. The same, dorsal view.
VII. Anal appendages of *Platysticta deccanensis* Laid., seen from the right side.
VIII. The same of *Ceylonosticta digna* (Selys), seen from the right side.
IX. The same, dorsal view.
X. The same of *Drepanosticta viridis* Fras., ventral view.
XI. The same of *Ceylonosticta montana* (Selys), right dorso-lateral view.

(Camera lucida studies, all drawn to the same scale.)

Wings hyaline palely tinted with yellow; pterostigma subquadrate but slightly longer than broad, inner border very oblique, outer slightly convex, costal border four-fifths the length of posterior, dark reddish brown framed finely in yellow and enclosed in thick black nervures; 20-25 postnodal nervures in forewings, 19 in the hind; *ac* and *ab* meeting the posterior border of wing at a common point, *ab* meeting discoidal cell nearer its base than outer end.

Abdomen black above, yellow along the ventral border and below, the sides of segments 1 and 2 and base of 3 pale yellow, this colour forming basal annules interrupted on the dorsum on segments 3 to 7. Segments 8 to 10 azure blue on dorsum, this colour broad at apical end of segment 8 and tapering to a fine point on the middorsum just short of the base of segment; segment 10 black at sides.

Anal appendages black, paler at apices; superiors nearly twice the length of segment 10 which is very short; seen from above these appendages are forcipated curling gently inwards at apices, broad at base then tapered at the middle, again abruptly dilated on the inner side, from which point as far as apex they are of even width and spatulate (The whole appendage viewed from above resembles a Krop razor with its blade nearly fully opened). Inferior appendages rather more than half the length the superiors, very broad at base, tapering rapidly to an obtuse point, the apical fourth angulated inward; a small subbasal tubercle on the inner side.

Female. Abdomen 36 mm. Hindwing 29 mm.

Closely similar to the male save for sexual characters. Prothorax with two curious bosses on the dorsum of middle lobe; segments 8 and 9 blackish brown on dorsum, unmarked with blue; segment 10 with a large spot of blue on the middorsum, its apical border ridged. Vulvar scales robust, extending beyond end of abdomen, minutely spined below; anal appendages short, pointed at apex, conical, as long as segment 10.

Distribution.—Confined to the hilly tracts of Ceylon at elevations of 3,000 to 4,000 ft. Rhambodda, Punduloya, Urugalla during April and May.

In the British Museum collection there are no less than three species included under the head of *P. maculata* but I do not think that there is much doubt as to which of these is the actual species under discussion. The description given here is from specimens collected by Col. F. Wall at Urugalla and compares so closely with the original description that there can be no doubt as to the correct identification of Col. Wall's specimens.

Platysticta apicalis Kirby.

Platysticta apicalis Kirby, Journ. Linn. Soc. (Zool). xxiv. pp. 561, 562 Pl. xlii, fig. 1. (1893); Laid. Rec. Ind. Mus. vol. xiii, p. 341 (1917); Id. Ibid. vol. xi p. 387 (1915); Id. *Spolia zeylanica.* vol. xii. p 361 (1924).

Male. Abdomen 48 mm. Hindwing 34 mm.

Head velvety black with a steely blue reflex; labium pale brown; labrum, bases of mandibles, ante-and post-clypeus azure blue, rest of head unmarked. Eyes black above, dark brown below.

Prothorax azure blue, posterior lobe black.

Thorax steely black with a blue reflex, marked on each side with a narrow oblique azure blue stripe on the mesepimeron. Beneath and along lower border of metepimeron pale yellow.

Legs black, coxæ, trochanters and bases of all femora pale yellow. Wings hyaline with the apices of all blackish brown as far proximad as the inner end of pterostigma which structure is twice as long as broad, inner end oblique, outer end angulated or convex, covering one or two cells, dark blackish brown; 19 postnodal nervures in forewings, 18 in the hind; *ac* very oblique and meeting *ab* very near the posterior margin of wings; other features of venation as for the genus.

Abdomen black on dorsum, yellow low down on the sides and beneath except for the last few segments. Segments 8 to 10 azure blue on dorsum, but the base of the former segment narrowly black which projects into the blue along the middorsal carina as a tapering point.

Anal appendages black; superiors two and a half times as long as segment 10 which is very short, broad at base, then tapered as far as the middle where it again dilates as a compressed spatulate apex somewhat squared at the end.

Seen in profile, the appendage is convex dorsally and rather strongly curved at its middle. Inferiors about four-fifths the length of superiors, very broad at base, then tapered as far as apex which ends in an acute abruptly turned-up point ; a very robust spine projecting back from the dorsum near its base.

Female. Abdomen 42 mm. Hindwing 36 mm.

Closely similar to the male except for sexual characters, differing only by its wings which are tipped with yellow instead of blackish brown, and by the terminal abdominal segments the 8th being entirely black, 9 with a small greenish blue or yellow spot on each side and 10 with its dorsum greenish blue or yellow. Anal appendages conical, pointed at apex, as long as segment 10. Vulvar scales robust, extending to end of abdomen.

Distribution.—Ceylon only, confined to the montane tracts. Belihul-Oya during June, and Madulsima where Mr. Bainbrigge Fletcher took a few specimens during August. It is probably on the wing from June to August or September. The species is probably very local and has only been taken in the years 1892 and 1908 ; it should not be difficult for Ceylon entomologists to rediscover this beautiful insect and give us some account of its habits.

Platysticta deccanensis Laidlaw.

Platysticta deccanensis Laid. Rec. Ind. Mus. vol. xi, p. 388, text-fig-1. (1915) ; Id. ibid. vol. xiii, pp. 340, 341, Pl. xv. fig. 4. (1917) ; Fras. Id. vol. xxvi, pp. 498, 499 (1924).

Male. Abdomen 45–47 mm. Hindwing 31–32 mm.

Head.—Labium yellowish ; labrum and anteclypeus azure blue, the former narrowly bordered with black ; postclypeus azure blue bordered above with black ; rest of head matt black ; 3rd joint of antennæ brownish at its distal end ; eyes black above, olivaceous brown below :

Prothorax dark reddish brown above paling to light red at the side and yellowish beneath.

Thorax bright brick-red changing to golden yellow low down on the sides and pale yellow beneath. Middorsal carina and antealar sinus narrowly marked out in black.

Legs reddish brown, femora at proximal ends and coxæ and trochanters golden yellow.

Wings palely enfumed, hyaline ; pterostigma dark red framed finely in light yellow and heavy black nervures, not quite twice as long as broad, inner end pointed, outer border straight, costal border shorter than posterior, covering 1 to 2 cells ; *ac* meeting *ab* at the posterior margin of wing or a short stalk intervening, *ab* short and often sinuous ; 17 to 21 postnodal nervures to fore-wings, 17–19 in the hind.

Abdomen dark reddish brown paling to golden yellow beneath at bases of segments 2 to 6 ; segments 8 to 9 azure blue but segment 8 has a narrow black basal annule and both it and 9 are bordered below with black ; segment 10 blackish brown, very narrow.

Anal appendages black, subforcipate as seen from above ; superiors broad at base constricted at about the middle where a robust obtuse spine is seen on the inner side, then broadened and somewhat spatulate for the apical half which is curled down and in and hollowed out ; inferiors nearly as long as superiors, broad at base then tapered as far as apex which ends in an obtuse point turned slightly inward.

Female. Abdomen 36–40 mm. Hindwing 28–29 mm.

Differs rather widely from the male, far more so than is usual in the subfamily ; head similar to male ; prothorax coloured similarly, the posterior lobe very broad, rounded.

Thorax brick-red, the middorsal carina and antealar sinus mapped out in black, the dorsum and anterior half of mesepimeron black but the ground colour showing as a fine line against the middorsal carina and upper humeral region, the humeral suture being finely delineated in reddish and the upper and lower part of mesepimeron more broadly so. Traversing the black of dorsum is a narrow antehumeral pale blue stripe convex inwards and not extending to upper part of thorax : bordering the black area of mesepimeron, another similar blue stripe (a beautiful ensemble of colours) ; beneath as for male.

Legs and abdomen similar to male but segment 1 bright brick-red at the sides, segment 8 unmarked with blue, segment 9 with a large oval pale blue

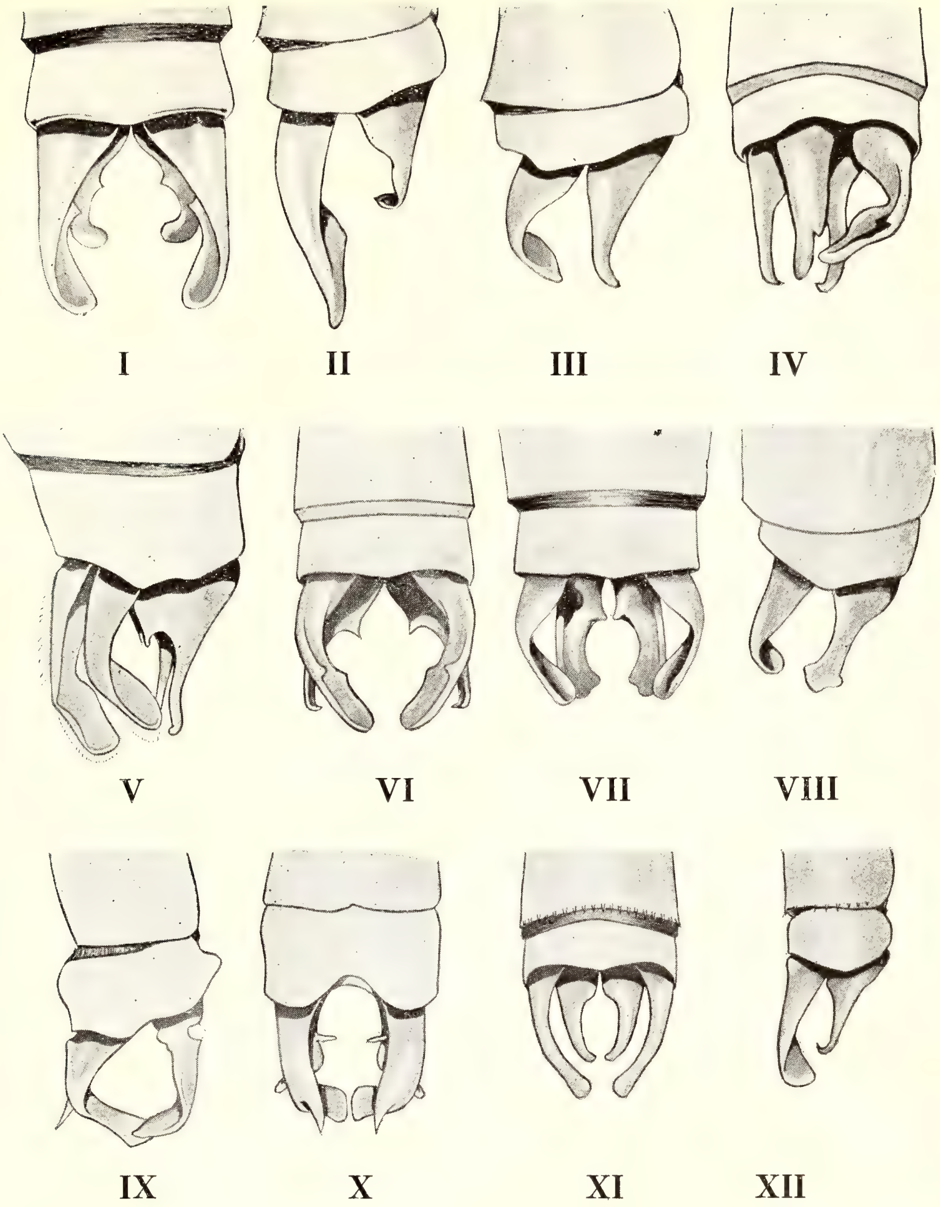


Plate II.

I. Anal appendages of *Platysticta maculata* Selys, dorsal view.
II. The same, seen from the right side.
III. Anal appendages of *Drepanosticta carmichaeli* Laid., seen from the right side.
IV. The same, dorso-lateral view.
V. Anal appendages of *Ceylonosticta hilaris* (Selys.), seen from the right side.
VI. The same, dorsal view.
VII. Anal appendages of *Ceylonosticta nietneri* sp. nov., dorsal view.
VIII. The same, seen from the right side.
IX. Anal appendages of *Drepanosticta viridis* (Fras), dorsal view.
X. The same, seen from the right side.
XI. *Ceylonosticta lankanensis* sp. nov., anal appendages dorsal view.
XII. The same, seen from the right side.
Camera lucida studies, all drawn to the same scale.

lateral spot. Segments 7 to 10 are blacker than in the male, segment 8 only about one-fourth the length of seven, segment 9 nearly twice the length of 8, and segment 10 very short as in the male.

Anal appendages short, not longer than segment 10, reddish brown, pointed, conical. Vulvar scale very long and robust, extending well beyond end of abdomen and with a robust spine above the end.

Wings usually more deeply enfumed than in the male, pterostigma of similar shape but more blackish than reddish brown ; 20 postnodal nervures in forewings, 17 in the hind.

Distribution.—Confined so far as known to Cochin, South India. The type is in the Indian Museum and was taken at Kavalai, Cochin State on 24-27. ix. 14. Wishing to obtain more of these interesting and beautiful insects and to study their habits, I revisited Kavalai in September, 1928, and took 17 males and 4 females at the same stream as the types came from. Most were found resting on maidenhair fern in dark shady spots, a number being seen in a culvert running beneath the forest railway. The red thorax and the blue identification marks, especially the latter, were very conspicuous. The flight of the insect is short and weak. Although very local, it was by no means uncommon and I suspect this to be the case with *P. apicalis* its near relation. The colouring of the female with its blue striped thorax is nothing less than remarkable and without parallel in an order where, if the female differs from the male, it is usually on the side of duller and less conspicuous colouring. It would suggest a more primitive insect in which both sexes were black with blue antehumeral and lateral stripes as is the case with Indoneuras, the male having subsequently lost these markings in favour of heliochromatic tints.

CEYLONOSTICTA gen nov.

Platysticta 2me groupe Selys, Syn. Agr. Derniere Legion, sep. p. 9 (1860).

Dragonflies of smaller size than the last genus but with similar habits and characters. Body-colouring black and brown with blue markings. Wings closed when at rest, long, narrow, falcate at apex. with a long petiole, hyaline, never opaque ; discoidal cell shaped as in *Platysticta* ; sectors of arc arising from lower part of arc *but fused for* a short distance from origin ; an accessory basal postcostal nervure present near the base of wings in addition to the nervure *Ac* which is situated rather nearer the distal antenodal nervure ; *Ab* always present but incomplete, meeting *Ac* at or a little away from the posterior margin of wing and extending to the posterior side of the discoidal cell which it meets at a point near its proximal end ; *IA* absent ; *Cuii* of about 6 to 8 cells in length; *MA* and *IRiii not zigzagged at origins* ; *Riv + v* arising a short distance proximad to, at or slightly distad of the oblique nervure descending from the subnode, *IRiii* at or slightly distad the level of subnode ; pterostigma similar to genus *Platysticta* ; cells of wings mainly quadrangular.

Head, thorax and abdomen similar to *Protosticta* but the latter less than double the length of wings ; anal appendages variable, superiors usually somewhat forcipate and spatulate at apices ; inferiors tapering from base to apex or more widely variable in the species. Genitalia of both sexes very similar to genus *Platysticta*.

Larvæ unknown. Genotype.—*Ceylonosticta hilaris* (Selys).

Distribution.—Confined to Ceylon in montane and submontane tracts. Habits similar to those of *Platysticta* so far as known. The original descriptions are poor so that without the actual types before one, it has been difficult or impossible to accurately determine the available material. Four species were originally described by Selys but a fifth has been described since by Dr. Laidlaw under the heading of *Drepanosticta sp.* which he surmises however, and I think with good reason, may be conspecific with *P. hilaris* Selys. Another pair, also described as *Drepanosticta sp.*, but presumably differing from the above, was said by the same author, to be too damaged to identify. I have also found some difficulty in determining some material before me, collected by Col. F. Wall, I.M.S., several species of which do not compare exactly with the Selysian descriptions. Thus it is certain that more species remain to be described and three of such have been named below. Further material is greatly to be desired and it is hoped that Ceylon entomologists will assist us in elucidating this problem.

Key to species of genus *Ceylonosticta.*

1.	Moderately large species with abdomen more than 40 mm. in length	2
	Smaller species with abdomen less than 40 mm. in length	4
2.	Anterior lobe of prothorax prolonged forward as two stalked process	*C. tropica* (Selys.)
	Anterior lobe of prothorax simple	3
3.	Inferior anal appendages acutely pointed ; labrum bordered with black	*C. hilaris* (Selys.)
	Inferior anal appendages obtuse at apex ; labrum not bordered with black	*C. montana* ,,
4.	Inferior anal appendages viewed dorsally squared at apex and with a very robust subapical spine directed inwards to meet its fellow across the middle line	*C. digna* ,,
	Inferior anal appendages simple, without subapical spine	5
5.	Very small species with abdomen less than 30 mm. in length ; labrum finely bordered with black ; inferior anal appendages acuminate at apex ; posterior lobe of prothorax simple	*C. lankanensis* sp. nov.
	Very small species with abdomen less than 30 mm. in length ; labrum broadly bordered with black ; posterior lobe of prothorax prolonged into a long tapering point	*C. walli* sp. nov.
	Larger species with abdomen more than 30 mm in length ; inferior anal appendages trilobate at apex	*C. nietneri* ,,

Ceylonosticta hilaris (Selys).

Agrion hilare Hagen, Verhand. zool-bot-Gesell. Wien, vol. viii, p. 479 (1858). Name only given.

Disparoneura hilaris Id. ibid. vol. ix, p. 206 (1859). Name only given.

Platysticta hilaris Selys, Bull. Acad. Belg. (2) x. p. 438 (1860) ; Id. Syn. Agr. sep. pp. 11 and 12 (1860) ; Id. Rev. Syn. Agr. sep. p. 151 (1886) ; Id. Mem. Cour. xxxviii, p. 152 (1886) ; Kirby, Cat. Odon. p. 132 (1890) ; Id. Journ. Linn. Soc. Zool. vol. xxiv, p. 562 (1893) ; Laid. Rec. Ind. Mus. vol. xi, p. 387 (1915).

Drepanosticta hilaris Laid. *Spolia Zeylanica,* Vol. xii. pp. 362, 364 (1924).

Drepanosticta sp. Laid. 1. c. Vol. xii, pp. 362-364 (1924).

Male. Abdomen 42 mm. Hindwing 25 mm.

Head.—Labium brown ; labrum pale turquoise blue narrowly bordered with glossy black ; bases of mandibles glossy black, the extreme base only blue ; anteclypeus turquoise blue ; postclypeus glossy back, rest of head bronzed black with a large patch of obscure reddish brown partially encircling the ocelli behind and on each side ; eyes black above, olivaceous brown beneath ; occiput with a projecting scale like ledge pointed at either end overlapping anterior lobe of prothorax.

Prothorax bronzed brown on dorsum, paler brown laterally ; anterior lobe sloping forward encircling the neck like a stiff collar ; middle lobe with a deep central pit situated between two prominent rounded bosses ; posterior lobe simple rounded, the posterior border straight or very shallowly concave.

Thorax bronzed black or deep coppery brown on dorsum changing to reddish brown and then ochreous on the sides and beneath. A narrow oblique azure blue stripe on each side traversing the centre of mesepimeron, after which is a thin black line on the postero-lateral suture. (In the original description the blue stripe is omitted probably because decomposition had obscured it.)

Wings hyaline, enfumed and tinted palely with yellow ; pterostigma reddish brown finely framed in yellow and thick brown nervures, rather longer than broad, inner side a little oblique, outer nearly straight ; 15–16 postnodal nervures in forewings, 14–15 in the hind ; *Riv+v* arising slightly distad or in continuation of the oblique nervure descending from the subnode ; *ab* meeting near the hinder border of wings.

Legs yellow or olivaceous, outer surfaces of femora and articulations blackish.

Abdomen dark reddish brown deepening to bronzed black at ends of segments ; sides of segments 1 and 2 paler ; segments 3 to 7 with moderately broad basal annules ; segment 8 with its apical border broadly and the whole of segments 9 and 10 azure blue, reddish brown below and along ventral borders.

Anal appendages blackish brown ; superiors more than twice the length of segment 10, broad at base then tapering and curving down in the apical half which is broadened out, excavated on its inner side and squared at the apex. A small dorsal spine situated at the point where the appendage begins to broaden out. Inferior appendage slightly shorter than superiors, very broad at base where is situated a robust dorsal spine, then slender and tapering to an acute point at apex.

Female. Abdomen 36-37 mm. Hindwing 26-27 mm.

Closely similar to the male in colouring and markings,—differs as follows :—border of labrum less broadly bordered with black and the black border itself bordered with reddish brown ; legs yellow, articulations only blackish. Wings more deeply enfumed ; 15-17 post-nodal nervures to forewings, 14–15 in the hind ; *Riv + v* arising proximal to the oblique nervure descending from the subnode. Abdomen similar but the basal annules pale blue in old specimens, yellow in others and tenerals ; segment 8 unmarked with blue, 9 with only a small subdorsal oval spot near the apical border of each side of segment, 10 with a large dorsal spot.

Anal appendages reddish brown, conical, pointed at apex, barely as long as segment 10 ; vulvar scale robust, extending well beyond end of abdomen.

Distribution.—Ceylon only. Rhambodda Ghat, Kandy and other montane areas from May to September. The figure given of the anal appendages by Dr. Laidlaw for his *Drepanosticta sp.*, is sufficient proof that this species is *C. hilaris* as he surmised. Post-mortem decomposition accounts for the differences to be noted between the above and the Selysian description. From *C. digna*, this species is easily distinguished by the shape of its inferior appendages ; from *C. tropica* by the simple collar-like anterior lobe of prothorax ; from *C. montana* by the labrum bordered with black and by the inferior appendages ending in an acute point ; from the remaining species by its much larger size and more numerous postnodal nervures.

Ceylonosticta montana (Selys.)

Platysticta montana Selys, Bull. Acad. Belg. (2) x. p. 438 (1860) ; Id. Syn. Agr. sep. pp. 10-11 (1860) ; Id. Mem Cour. Rev. Syn. Agr. p. 151 (1886) ; Kirby. Cat. Odon. p. 132 (1890) ; Id. Journ. Linn. Soc. Zool. vol. xxiv, p. 363 (1893) ; Laid. Rec. Ind. Mus. vol. xi, p. 387 (1915).

Drepanosticta montana Laid. *Spolia zeylanica.* vol. xii, p. 362 (1924).

Male. Abdomen 43 mm. Hindwing 28 mm.

Head—Labium dark brown ; labrum turquoise blue narrowly bordered with reddish brown ; bases of mandibles and anteclypeus turquoise blue ; postclypeus glossy black, rest of head bronzed black with a broad patch of reddish brown encircling the ocelli on either side and behind ; eyes black above, olivaceous brown beneath.

Prothorax bronzed brown on dorsum, paler reddish brown laterally ; anterior lobe collar-like ; posterior lobe simple, rounded.

Thorax bronzed black on dorsum changing to reddish brown on the sides and yellowish beneath. (Probably an oblique blue stripe on the middle of mesepimeron but obscured by decomposition in the type.)

Legs yellowish, the outer surface of femora and articulations blackish.

Wings hyaline, palely enfumed ; pterostigma slightly longer than broad, similar in shape to that of *C. hilaris* ; 16-18 postnodal nervures in forewings, 15-16 in the hind ; *Riv + v* arising a little distad of the oblique nervure descending from the subnode.

Abdomen bronzed brown on dorsum deepening to black at the distal ends of segments ; segments 3 to 7 with moderately broad basal annules ; segment

8 unmarked (so far as can be seen in the type, but probably its apical border bluish during life); segments 9 and 10 azure blue on the dorsum. (In the type, segment 9 brown from decomposition.)

Anal appendages blackish brown, superiors more than twice the length of segment 10, broad at base then tapered as far as the middle, at which point they are dilated internally and curved rather strongly downward and furnished with a small obtuse spine at the point of the angulation on the upper inner border of appendages ; the dilated part of even width, excavate on the inner side and ending in a squared apex directed somewhat inward and downward. Inferiors slightly shorter than superiors, broad at base, then tapered and slim as far as apex which is again broadened and curved inward towards its fellow ; a robust tooth on the upper inner border near the base.

Female. Abdomen 37 mm. Hindwing 26 mm.

Closely similar to the male, differing only in sexual characters and by the markings on the terminal segments of abdomen. A small subdorsal subapical spot of blue on each side of segment 9, and a broad dorsal spot of the same colour on segment 10. Anal appendages as long as segment 10 which is very short and without an apical notch, conical, pointed at apex, brown. Vulvar scale very robust, extending well beyond end of abdomen.

Distribution.—Ceylon only, in montane tracts, Rhambodda Ghat and Kandy. Differs from *C. tropica* by the simple shape of the lobes of prothorax ; from *C. hilaris*, to which it is very closely related, by the tumid end of inferior appendages and by the labrum unbordered with black ; from *C. digna* by the absence of a middle inner spine on inferior appendages. From the remaining species by its much larger size.

Ceylonosticta tropica (Selys.)

Platysticta tropica Selys. Bull. Acad. Belg. (2). x. p. 438 (1860) ; Id. Syn Agr. sep. p. 10 (1860) ; Id. Mem. Cour. Rev. Syn. Agr. p. 151 (1886) ; Kirby, Cat. Odon. p. 132 (1890) ; Id. Journ. Linn. Soc. Zool. vol. xxiv. p. 562 (1898) ; Laid. Rec. Ind. Mus. vol. xi. p. 387 (1915) ; Id. Ibid. vol. xiii. p. 341 (1917).

Drepanosticta tropica Laid. Spolia Zeylanica. vol. xii. p. 362 (1914).

Male Abdomen 41 mm. Hindwing 26 mm.

Head—Labium pale brown ; labrum, bases of mandibles and anteclypeus pale turquoise blue, the former narrowly bordered with brown ; postclypeus bronzed brown above, rest of head bronzed black with a small obscure yellow oval spot on the outer side of each outer ocellus ; eyes black above, olivaceous brown beneath ; 2nd and 3rd segments of antennæ pale yellowish.

Prothorax pale olivaceous brown, the middle lobe possibly bluish during life ; posterior lobe bronzed black, arched, rounded ; anterior lobe with a deep and wide cleft at its middle, the lobe on each side of this prolonged into a curious stalked scale resembling those seen on the posterior lobe of some of the *Caconeura* group ; between these two scales the lobe prolonged forward as a short blunt process.

Thorax dark bronzed brown or cupreous black on dorsum, the lower part of sides paling to reddish brown and then yellow beneath thorax ; a moderately broad oblique azure blue stripe on each side traversing the centre of mesepimeron from above down.

Legs olivaceous, the external and extensor surfaces of femora and the articulations mottled with black.

Wings hyaline palely enfumed ; pterostigma blackish brown finely framed in creamy white and again by thick black nervures, half as long again as broad, costal border shorter than posterior, distal border straight, proximal very oblique, braced ; *Riv + v* arising slightly before the oblique nervure descending from the subnode ; 16–17 postnodal nervures to forewings, 14–16 in the hind ; *ab* meeting *ac* at a short distance from posterior margin of wing.

Abdomen bronzed brown deepening to black at apical ends of segments and with narrow basal annules on segments 3 to 7 ; segment 1 yellow laterally; segments 2 to 4 yellow along the ventral borders ; segments 9 and 10 azure blue on the dorsum, the latter narrowly black at the apex.

Anal appendages blackish brown ; superiors more than twice as long as segment 10 ; seen from above curving gently inward towards one another ; broad at base then tapered to apex which is obtuse, the apical half presenting a spatulate-like dilation on the inner border which is hollowed out on its inner aspect. Inferior appendages rather more than half as long as superiors, very broad at base where is seen an inner tubercle which, viewed from above, is broad and coated with numerous stiff bristles. The apical three-fourths slim, sloping up and back and ending in an obtuse shallowly-notched apex as viewed in profile, or as an acutely-pointed, inwardly directed spine as viewed from above.

Female. Abdomen 40 mm. Hindwing 29 mm.

Closely similar to the male in colour and markings but rather more robustly built. Labium dark brown ; labrum entirely blue ; prothorax with similar scale-like processes on anterior lobe ; wings more deeply enfumed ; 16 to 17 postnodal nervures to forewings, 16 in the hind ; other details of venation similar to the male. No trace of blue to be seen on the terminal abdominal segments but these may be obscured by post-mortem decomposition, and during life are probably present as subdorsal spot on the sides of segment 9 and a large dorsal spot on segment 10. Anal appendages short, barely as long as segment 10, conical pointed, brown ; segment 9 about one-third longer than 8 and more than twice the length of 10. Vulvar scales moderately robust, blackish brown, *not extending to end of abdomen.*

Distribution.—Confined to the montane tracts of Ceylon. Passara, Haycock Hill, May to August. Hakgala, March and April. The description of the female which has not hitherto been published, is from a specimen in the author's collection from Hakgala.

There is no possibility of confusing this species with any other as the curious prothoracic processes are unique in the genus and are sufficient to determine the species at a glance. It is of interest to note that these accessory sexual appendages are found in both sexes.

Ceylonosticta digna (Selys.)

Agrion digna Hagen, Verhandl. Zool-bot. Gesell. Wien, vol. viii. p. 479. (1858).

Disparoneura digna, Hagen, Ibid. vol. ix. p. 207 (1859). Name only.

Platysticta digna, Selys, Bull. Acad. Belg. (2) vol. x. p. 440 (1860) ; Id. Syn. Agr. sep. p. 12 (1860) ; Id. Mem. Cour. Rev. Syn. Agr. xxxviii. p. 151 (1886) ; Kirby. Cat. Odon. p. 132 (1890) ; Id. Journ. Linn. Soc. Zool. vol. xxiv. p. 362 (1893) ; Laid. Rec. Ind. Mus. vol. xi. p. 387 (1915).

Drepanosticta digna, Laid. Spolia Zeylanica, vol. xii. pp. 361, 362, text-figure 9 (1924).

Male. Abdomen 35 mm. Hindwing 23 mm.

Head.—Labium pale brown ; labrum, bases of mandibles and anteclypus pale turquoise blue ; postclypeus glossy black, rest of head blackish brown ; eyes black above, olivaceous brown beneath ; 3rd joint of antennæ palest brown. Occiput with the usual scale-like ledge posteriorly.

Prothorax ochreous, possibly blue on the dorsum during life ; anterior lobe arched, sloping forward, collar-like ; posterior lobe simple, rounded, dark bronzed brown.

Thorax dark bronzed brown on dorsum paling to reddish brown laterally and yellowish beneath ; middorsal carina finely blue and an oblique stripe of the same colour traversing the length of mesepimeron midway between the two lateral sutures.

Legs ochreous, outer surface of femora and all articulations blackish brown.

Wings hyaline palely enfumed in adults ; pterostigma blackish brown finely framed in yellow and an outer frame of thick black nervures shaped similarly to that of *C. hilaris ;* 15–16 postnodal nervures to forewings, 14 in the hind ; *Riv+v* arising in prolongation of the oblique nervure descending from the subnode ; *ac* and *ab* meeting at a common point on the posterior margin of wing or a short stalk intervening at the junction.

Abdomen blackish brown, segments 2 and 3 at the sides and the bases of 2 to 7 with basal annules yellow ; segment 8 black ; segments 9 and 10 azure blue above, black along the ventral borders.

Anal appendages blackish brown ; superiors more than twice the length of segment 10, broad at base, then tapering somewhat to apex which is obtuse, slightly curved in and down as viewed from above, and the apical half which is a little expanded on the inner side, markedly excavate. Inferior appendages about two-thirds the length of superiors, of unusual and irregular shape, very broad at base, outer border sinuous as seen from above, inner border deeply serrate, presenting an obtuse basal tubercle followed by a subbasal which is followed successively by a deep notch, a median robust spine and then a final shallow notch ; the median spine is directed straight inwards and nearly meets its fellow on the opposite side ; the apex squared and slightly bevelled. Seen from the side the appendage tapers rapidly to an obtuse point. Female unknown.

Distribution.—Ceylon only in montane tracts. Rhambodda Ghat and Haragama from May to August. The above revised description was made from a specimen in the British Museum. The species is easily determined from all others by the curiously shaped inferior appendages. Type in the Selysian collection.

Ceylonosticta nietneri sp. nov.

Male. Abdomen 31-32 mm. Hindwing 20–21 mm.

Head.—Labium pale brown ; labrum, bases of mandibles and anteclypeus pale turquoise blue ; postclypeus glossy black, rest of head bronzed black ; 3rd joint of antennæ pale brown ; eyes black above, olivaceous brown beneath ; occiput with a similar scale as seen in *C. hilaris*.

Prothorax pale ochreous ; posterior lobe except its hinder border and the whole of the dorsum of middle lobe pale blue ; anterior lobe collar-like, posterior rounded, simple.

Thorax bright reddish ochreous with a cupreous reflex on dorsum and a broad oblique pale blue stripe on each side situated between the two lateral sutures ; pale ochreous beneath.

Legs pale olivaceous, the articulations speckled with black.

Wings hyaline, very palely enfumed ; pterostigma blackish brown finely framed in creamy white and thick black nervures, nearly square, but slightly longer than broad, distal side convex, proximal oblique, braced ; 14–16 postnodal nervures in forewings, 13–14 in the hind ; *ab* meeting *ac* at a short distance from the posterior margin of wing, the former ending very near the proximal end of discoidal cell ; origin of $Riv + v$ at or slightly distad of the oblique nervure descending from the subnode.

Abdomen yellow beneath and on the sides of segment 1, dark enfumed olivaceous on dorsum and sides, deepening to black at apical ends of segments, and on the whole of segment 7 and most of 8 ; bases of segments 3 to 4 or 5 with incomplete basal annule which extend apicad along the ventral borders of segments ; segment 8 blackish brown marked dorsally with an apical triangle of azure blue which extends variably towards base of segment covering from one-fourth to half the segment ; segments 9 and 10 entirely blue on dorsum, the ventral borders black.

Anal appendages blackish brown, apices of inferiors paler brown ; superiors twice the length of segment 10, simple, arched up and then down, broad and depressed at base, then, at the middle, twisted on the long axis of appendage, the outer half broadened compressed and hollowed out within, *not bearing any spines* ; inferior appendages of the same length, broad at base, directed straight back or a little obliquely upward, of even thickness throughout as far as apex which is expanded into three angles like the webbed foot of a duck ; *without a basal spine.*

Female. Abdomen 30–31 mm. Hindwing 22 mm.

Closely similar to the male but of stouter build, the abdomen more especially robust. Differs as follows,—Prothorax more prominently marked with blue on middle and posterior lobes, the latter very simple rounded, the scale-like border very narrow and of even width.

Wings with 14 postnodal nervures to forewings, 13 in the hind, otherwise exactly similar to those of male, but $Riv + v$ always arising distad the oblique nervure descending from the subnode.

Abdomen dark reddish brown, segments 3 to 7 with broad basal azure blue annules interrupted on the middorsum on the latter segment ; segment 8 dark reddish brown, the apical articulation only blue ; segments 9 and 10 broadly azure blue on dorsum, reddish brown on lower part of sides.

Anal appendages shorter than segment 10, small pointed conical processes, brown. Vulvar scale brown, robust, extending beyond end of abdomen.

Distribution.—Ceylon only, Kandy, 2,000 ft. Three males and a single female taken at the latter place by Col. F. Wall, I.M.S., 14. x. 24.

This species and the two following—*C. lankanensis* and *C. walli* are the three smallest species known in the subfamily, not excepting *P. hearseyi* and may be distinguished from all other species at a glance by reason of this feature. The curious shape of the apex of the inferior anal appendages, shaped like a duck's foot, will serve to distinguish it from the other two species mentioned of the same size as itself. The female is to be distinguished by the arched rounded shape of its prothorax, this being produced and strongly angulated in *C. walli*, whilst the female of *lankanensis* is unknown.

Ceylonosticta lankanensis sp. nov.

Platysticta montana Kirby, Journ. Linn. Soc. Zool. vol. xxiv. p. 562 (1893).

Male. Abdomen 29 mm. Hindwing 20 mm.

Head.—Labium whitish brown : labrum, bases of mandibles and anteclypeus pale turquoise blue, the former very narrowly bordered with black, rest of head blackish brown ; eyes dark brown above, olivaceous brown beneath.

Thorax dark reddish ochreous on dorsum and sides but paling to ochreous on metepimeron and yellowish beneath. A broad oblique pale blue stripe on each side lying parallel with and midway between the lateral sutures, contrasting strikingly with the adjacent reddish brown.

Legs olivaceous marked with dark brown on the outer sides of femora and all articulations.

Wings hyaline, palely enfumed ; pterostigma blackish brown, finely framed in white and thick black nervures, similar in shape to that of *C. nietneri* ; 12-13 postnodal nervures in forewings, 11 to 12 in the hind ; *Riv.* + *v* arising in continuation with the oblique nervure descending from the subnode ; *ab* meeting *ac* near the posterior margin of wings.

Abdomen reddish brown deepening to black at apical ends of segments ; segment 1 yellow laterally ; segments 3 to 7 with narrow basal yellow annules ; segment 8 with a small apical triangular bordering of blue ; segments 9 and 10 azure blue dorsally, black along the ventral borders.

Anal appendages blackish brown, superiors more than twice the length of segment 10, broad at base then tapering as far as the middle, at which point they are dilated, compressed and rotated on their long axis, the apex broad and squared ; seen from above these appendages are curved gently towards one another, of almost even breadth throughout and slightly clubbed at apex ; inferiors of about two-thirds the length of superiors, very broad at base, then abruptly slim and cylindrical, curved gently in, the extreme apices more abruptly so and ending in a fine point.

Female unknown. Type in the British Museum.

Distribution.—Ceylon only, confined probably to montane districts. The type is labelled—' Kottawa, 19. iv. 92,' and is incorrectly determined by the late Mr. Kirby as *P. montana*. This specimen is undoubtedly Col. Yerbury's referred to by Kirby as *P. montana* ' with some doubt ' in the J.L.S.l.c. Its small size, the smallest species of the genus, is sufficient to determine it from *P. montana* and several other differential points may be made out with ease. The acutely pointed inferior appendages are sufficient to determine it from *C. nietneri* which has them broad and clubbed at the apices and as long as the superiors. It is possible that the next species described below, is the female of this but the curious shape of the hinder margin of the prothorax in the latter and the extensive black bordering of the labrum appear to place it as an entirely distinct species.

Ceylonosticta walli sp. nov.

Female. Abdomen 31 mm. Hindwing 22 mm. (Male unknown.)

Head.—Labium blackish brown ; labrum pale turquoise blue broadly bordered with glossy black ; bases of mandibles black with a spot of blue at the extreme base ; anteclypeus pale turquoise blue, postclypeus and rest of head black bronzed ; eyes black above, olivaceous brown beneath : distal end of 3rd segment of antennæ pale brown.

Prothorax with middle lobe pale blue, anterior and posterior lobes reddish brown, the former collar-shaped, the latter with the medial portion of its thinned-out border prolonged into a long tapering point.

Thorax reddish ochreous deepening to dark bronzed brown on dorsum, paling on lower part of metepimeron and beneath ; a moderately broad azure blue stripe traversing the whole length of mesepimeron midway between the lateral sutures.

Legs olivaceous, articulations blackish, outer surfaces of femora and whole of tibiæ enfumed brown.

Wings hyaline, palely enfumed ; pterostigma nearly quadrate especially in the forewings, inner end slightly oblique, outer slightly convex, dark reddish brown framed finely in white and thick black nervures ; 15 postnodal nervures in forewings, 14 in the hind ; *Riv* + *v* opposite or a little distad of the oblique nervure descending from the subnode ; *ac* and *ab* arising from different points on the posterior border of wings (in the type the nervure *ab* is absent in the right pair of wings).

Abdomen reddish brown changing to blackish brown at distal ends of segments ; segments 2 to 7 with azure blue basal annules, very narrow on segment 2, broad on 4 to 6 ; segment 8 unmarked ; segments 9 and 10 with the dorsum azure blue, the ventral borders dark blackish brown.

Anal appendages reddish brown, slightly longer than segment 10, conical, acute at apex ; vulvar scale robust, extending beyond end of abdomen.

Distribution.—Ceylon only, confined to montane tracts. Type, a female, in the author's collection, taken at Kandy, 2,000 ft., 13. ix, 24 by Col. F. Wall, I.M.S. Differs from the female of *C. neitneri* by the posterior lobe of prothorax which is prolonged into a long tongue-like point and also by the labrum broadly bordered with black, by the higher nodal index, etc. From the male of *C. lankanensis* it also differs by the shape of the posterior lobe of prothorax, by the labrum broadly bordered with black, by the broader basal blue annules of the abdomen and by the different origin of *ab*, etc.

Genus : DREPANOSTICTA Laidlaw (1917).

Platysticta Selys. *pars.* Bull. Acad. Belg. (2) x. p. 436 (1860) ; Id. Mem. Cour. xxxviii, p. 150 (1886) ; Kirby, Cat. Odon. p. 132 (1890) ; Laid. Rec. Ind. Mus, Vol. xi, pp. 378, 379 (1915).

Drepanosticta Laid. ibid. vol. xiii, pp. 339, 341 (1917) ; Id. Journ. Malay branch Roy. Asia. Soc. vol. ii. pp. 304-306 (1924).

Dragonflies of the same small size as the last genus and with similar habits and characteristics. Body-colouring usually black, but in one species at least, reddish brown marked with blue. Wings closed when at rest, long, narrow, falcate at apex, with a long petiole, hyaline ; discoidal cell shaped as in *Platysticta ;* sectors of arc arising from lower part of arc *but fused for a short distance from origin ;* an accessory basal postcostal nervure present near base of all wings in addition to the nervure *ac*, which is situated rather nearer distal antenodal nervure , *ab* usually present *but sometimes absent* and, when present, always incomplete, meeting *ac* at or near the hinder margin of wing or arising from that margin at some point more or less distad of *ac* and extending to the posterior border of discoidal cell near its proximal end ; *IA* absent ; *Cuii* of variable length, usually 6 to 8 cells in length ; *MA* and *IRiii* not zigzagged at origins ; *Riv+v* arising slightly before, at or slightly distad the oblique nervure descending from the subnode ; *IRiii* at or a little distad of that nervure ; pterostigma subquadrate, costal side slightly shorter than the posterior, inner end oblique, unbraced, outer slightly convex. Cells of wings mainly quadrangular.

Head, thorax and abdomen similar to *Protosticta* but the abdomen less than twice the length of wings except in *D. viridis.* ; anal appendages variable, superiors subforcipate, spatulate in the apical half which is curved down and usually carries a robust dorsal spine at the middle ; inferiors variable, with or without a long inner narrow spine ; genitalia similar to that of Protosticta, *penis without a dorsal ruff or spine.* Larvæ unknown. Genotype.—*Drepanosticta carmichaeli* (Laid.)

Distribution.—N. E. India, Burma, Indo-China, Malaya to New Guinea. The habits of species of the genus are unknown save for *D. carmichaeli* which resemble those of *Protosticta.* Dark shaded retreats are the localities in which to seek these insects, where clinging to ferns, etc. they may be beaten up and driven into the open. Four or five species are known from within Indian limits, one of which is from Bengal, two or possibly three from Burma and a fifth from the Andamans.

Key to species of genus *Drepanosticta.*

1	Length of abdomen twice that of hindwing ...	*D. viridis* Fras.
	Length of abdomen considerably less than twice that of hindwing	2.
2	Species coloured black marked with white and pale blue	3.
	Species coloured reddish brown marked with blue	4.
3	Pterostigma slightly longer than broad ; thorax with ill-defined blue stripes, blackish brown beneath	*D. carmichaeli* Laid.
	Pterostigma squared ; thorax with well-defined blue stripes, beneath pale yellow... ...	*D. polychromatica* sp. nov.
4	Anal appendages complex, furnished with spines	*D. quadrata* Selys.
	Anal appendages simple, without any spines ...	*D. annandalei* Fras.

Drepanosticta carmichaeli Laid.

Protosticta carmichaeli Laid. Rec. Ind. Mus. vol. xi, p. 390, fig. 1 (1915).
Drepanosticta carmichaeli Laid. ibid. vol. xiii. pp. 341, 342, pl. xv. fig. 5 (1917) ; Id. Journ. Malay branch Roy. Asia. Soc. vol. ii, pp. 304-306 (1924).

Male. Abdomen 36-37 mm. Hindwing 23-24 mm.

Head.—Labium brown ; labrum turquoise blue narrowly bordered with dark brown ; genae, bases of mandibles and anteclypeus turquoise blue ; postclypeus, frons and vertex as far back as the level of posterior ocelli blackish brown, behind which an irregular broad band of pale blue extending from eye to eye ; occiput behind black, presenting a vestigial ridge behind as seen in *Platysticta* ; 2nd joint of antennæ pale blue ; eyes blue above, paler below and marked with a dark equatorial band of grey.

Prothorax with anterior lobe projecting forward collar like ; posterior lobe simple rounded ; middorsum olivaceous, the rounded bosses on each side of middle lobe azure blue ; posterior lobe reddish ochreous, blue at either side ; middle lobe dark chocolate brown on each side and beneath.

Thorax olivaceous on dorsum changing to golden brown laterally and then dark chocolate brown ventrad and beneath. An ill-defined pale blue antehumeral stripe on each side of dorsum confluent with the blue on posterior lobe of prothorax ; laterally a broad, slightly oblique pale blue stripe traversing the whole length of mesepimeron.

Legs pale ochreous, hind femora with a small distal point of black on extensor surface.

Wings palely enfumed, hyaline ; pterostigma rather longer than broad, costal side slightly shorter than posterior, proximal side very oblique, distal side slighty convex, covering 1 cell, unbraced, brown framed finely in creamy white and thick black nervures ; 15-16 postnodal nervures in forewings, 14 in the hind ; *Riv+v* arising distad the oblique nervure descending from the subnode ; *ac*, midway between the two antenodal nervures or nearer the distal one ; *ab* arising from the posterior border of wing well distad of *ac*, very oblique, meeting the discoidal cell near its proximal end, hardly longer than *ac* ; *Cuii* 8-9 cells long in forewings, 12 in the hind.

Abdomen dark golden brown deepening to blackish brown at apical ends of segments and on the whole of segments 7 to 10 ; segment 1 with an apical blue annule ; 2 with the middorsum narrowly turquoise blue from base nearly to apex ; segments 3 to 7 with bright blue basal cordate spots ; 8, 9 and 10 pale azure blue on dorsum, the lower parts of sides, especially of 10, black.

Anal appendages blackish brown, apices of superiors paler brown. Superiors broad at base, then tapering strongly till about the middle, the apical half expanded and curved strongly downward ; apex falcate ; a very obtuse spine on dorsum at the site of angulation ; equal to more than twice the length of segment 10 ; inferiors equal in length to superiors, very broad at base, then tapered, cylindrical and ending in a fine point which is curved inward ; a large robust acutely pointed spine situated at the base, directed inward and upward.

Female. Abdomen 34 mm. Hindwing 23 mm.

Almost exactly similar to the male but the abdomen shorter and stouter. Segments 8 and 10 unmarked with blue ; basal blue spots on segments 4 to 6 larger and more conspicuous ; wings similar to those of male but *Riv+v* arising rather more distad the subnode ; 16 postnodal nervures to forewings, 15 in the hind. Anal appendages short conical pointed, brown ; vulvars scales robust but not extending beyond end of abdomen.

Distribution.—Sikkim, Kalimpong, 4,000 ft., Pashoke 3,000 ft., from April to July, in similar situations to those frequented by *Protosticta.* The beautiful colour complex of this insect will serve to distinguish it from all others of the genus save its near relative *D. polychromatica* from which it is distinguished by its larger size, different character of the thoracic markings, different shape of pterostigma, distal origin of *Riv + v* and longer *Cuii.*

Drepanosticta polychromatica sp. nov.

Male. Abdomen 32 mm. Hindwing 21 mm. (Female unknown.)

Head.—Labium pale brown ; labrum, genae, bases of mandibles and anteclypeus palest blue, the former narrowly bordered with brown ; rest of head blackish brown as far back as the level of posterior ocelli, at which point is a moderately broad blue transverse band which falls well short of the eyes save for a minute point anteriorly.

Prothorax with dorsum chocolate brown, laterally blackish brown marked on the centre of middle lobe with a narrow yellow line, and on the sides by a broad band of blue extending from anterior to posterior lobe, the latter ochreous on the middorsum and shaped as in *D. carmichaeli.*

Thorax black on dorsum, dark chocolate brown laterally, the former marked with a well-defined narrow blue antehumeral stripe, broad anteriorly where it is confluent with the blue on prothorax, narrowing and tapering to a fine point near the antealar sinus posteriorly. Laterally a sharply-defined oblique moderately broad blue stripe lying just anterior to the postero-lateral suture, followed by an equally broad stripe of the ground colour ; lower part of metepimeron and beneath thorax pale yellow.

Legs pale ochreous, unmarked. Wings hyaline, palely enfumed ; pterostigma almost quadrate, costal side only a shade shorter than posterior, the proximal side but slightly oblique, dark brown finely framed in creamy white and thick black nervures ; 15 postnodal nervures to forewings, 14 in the hind ; *Riv + v* arising in continuation of the oblique nervure descending from the subnode ; *Cuii* only 7 cells long in forewings, 10 in the hind ; *ac* lying midway between the two antenodal nervures ; *ab* arising from *ac* or more usually from the posterior margin of wing a little distad of *ac* and longer and more oblique than in *D. carmichaeli.*

Abdomen yellow at the sides and beneath, enfumed on dorsum and deepening to blackish brown at apical ends of segments 3 to 6 to form rather sharply defined apical annules ; segment 2 with a narrow middorsal streak of blue not quite extending to apical border ; segment 3 with a pale blue dorsal basal spot, segments 6 to 7 with narrow pale blue complete basal annules ; dorsum and sides of segments 8 and 9 broadly pale azure blue ; segment 10 black, unmarked.

Anal appendages black, paler at apices, shaped similarly to those of *D. carmichaeli* but the inferiors stouter and the basal spine less pronounced.

Distribution.—Darjeeling district, Gopaldhara, May to July. Type in the author's collection. Distinguished from all other species of the genus by its colouring and from *D. carmichaeli* by the points enumerated under the description of that species. The sharply defined blue and dark brown stripes on the sides form the best medium for separating these two closely-allied species but in addition it is to be noted that whilst the thorax of *D. carmichaeli* is lighter than that of *D. polychromatica*, the abdomen is strikingly darker ; the 10th abdominal segment is blue in the former, unmarked in the latter.

Drepanosticta Viridis Fraser.

Drepanosticta viridis Fras. Mem. Pusa, Dept. Agric. Ind. (Ent.) vol. vii. No. 7. pp. 39, 40 (1922).

Male. Abdomen 50 mm. Hindwing 25 mm.

Head.—Labium palest brown ; labrum, bases of mandibles and anteclypeus palest blue, the former bordered narrowly with glossy black ; postclypeus glossy black, rest of head steely blue black ; eyes pale yellow, capped above with puce ; occiput ridged behind as in *Platysticta*.

Prothorax dirty yellow ; posterior lobe dark bronzed brown, broadly arched, simple ; anterior lobe collar-like.

Thorax dark metallic green or blue on dorsum changing to reddish brown at humeral region and pale brownish yellow laterally. Lateral sutures mapped out obscurely in pale brown, the anterior suture bordered broadly and diffusely with black. Beneath yellow.

Legs yellow with black spines ; extensor surfaces of femora blackish brown, tibiae olivaceous.

Wings hyaline ; pterostigma reddish brown, very small almost quadrate, costal border but slightly shorter than posterior, distal border convex, proximal but slightly oblique ; 14 to 15 postnodal nervures to forewings, 14 in the hind ; *ac* lying much nearer the level of distal antenodal nervure ; *ab* arising from posterior margin of wing well distad of *ac*, very short, hardly longer than *ac* ; *Riv* + *v* arising well distad of the oblique nervure descending from the subnode.

Abdomen of great length, very slim, resembling species of *Protosticta* more closely than any other species of the genus. Segments 1 to 7 brownish black, this colour deepening at apices of segments 2 to 7 but falling short of bases of segments where are seen narrow white basal annules ; segment 8 with the basal half azure blue on dorsum, black laterally and middorsally so that the blue of apex presents two points directed basad subdorsally ; segment 9 entirely pale azure blue on dorsum, segment 10 black, emarginate and with a deep depression on dorsum extending nearly as far as its base.

Anal appendages black ; superiors twice the length of segment 10, bent at a right angle at their middle, downwards and a little inwards, broad at base, presenting a needle-like dorsal spine at the point of angulation ; apex expanded, bevelled at end. Inferiors nearly as long as superiors, broad at base, then flattened, twisted spirally on their long axis at the middle of appendages, apical half angulated sharply upwards to meet and overlap apices of superiors ; a small needle-like spine on the inner border, directed inwards near the middle of appendages.

Female. Abdomen 37 mm. Hindwing 25 mm.

Closely similar to the male in colour and markings but shorter and more robustly built. Segments 8 and 9 without blue markings ; segments 1 to 6 with well-defined basal white annules, 7 without, otherwise all details, including venational ones similar to those of male.

Distribution.—King Island, Mergui, Lower Burma. Found beside marshes and small irrigation channels and streams in rubber plantations. Distinguished from all other species of the genus by the extreme length and attenuation of its abdomen which is exactly double the length of the wings as in species of *Protosticta*. The armature of the anal appendages recalls that of *P. himalaica*.

Drepanosticta Quadrata (Selys.).

Platysticta quadrata. Selys, Bull. Acad. Belg. (2) x. p. 441 (1860); Id. Syn. Agr. Derniere Legion. sep. p. 13 (1860); Id. Ann. Mus. Civ. Giv. Genov. (2) x. xxxii. pp. 507, 508 (1891); Kirby, Cat. Odon. p. 133 (1890); Laid. Fascic. Malay. Zool. Pt. iv. p. 11. fig. 1 (1907).

Drepanosticta quadrata. Laid. Rec. Ind. Mus. vol. xiii. p. 343 (1917); Id. Journ. Malay. Roy. Asia. Soc. vol. ii. pp. 304-306 (1924).

Male. Abdomen 35 mm. Hindwing 21 mm.

Head.—Labrum, bases of mandibles and anteclypeus palest blue, the former broadly bordered with glossy black ; postclypeus and rest of head black.

Prothorax creamy white ; posterior lobe black, simple.

Thorax bronzed black on dorsum, pale bluish laterally, pale yellow beneath. Laterally an oblique black stripe traversing the length of mesepimeron.

Legs pale, the extensor surfaces of femora and articulations black.

Wings hyaline; pterostigma subquadrate, black, finely framed in white and thick black nervures; *Riv+v* arising slightly distad the oblique nervure descending from the subnode; 11–12 postnodal nervures in forewings, 10–11 in the hind.

Abdomen blackish brown, segments 2 to 7 with a narrow yellow basal annule, the black expanding at apical ends of each segment to form broad apical annules; segment 8 with the apical half and 9 with the whole of dorsum pale blue; segment 10 black.

Anal appendages black, superiors twice as long as segment 10, slightly curved towards each other and downwards, a robust spine on the upper border of middle of appendage, apex slightly flattened and dilated. Inferior appendages of similar length, pale at base which is broad and presents an inner upper obtuse spine or tubercle, then tapering, subcylindrical, apex curved in, notched and preceded by a long inner spine.

Female. Abdomen 31 mm. Hindwing 18 mm.

Head.—Labrum dirty white; anteclypeus pale yellow; postclypeus and front of frons traversed by an obscure band; rest of head black.

Prothorax pale yellow; posterior lobe emarginate at middle, yellow with obscure greyish fascia.

Thorax bronzed black on dorsum as far lateral as the antero-lateral suture, the middorsum greyish yellow. Laterally and beneath pale yellow with a broad oblique brown stripe traversing the mesepimeron. Legs pale yellow, articulations obscure.

Wings similar to the male but *Riv+v* arising in continuation with the oblique nervure descending from the subnode.

Abdomen brownish black, segments 2 to 7 marked similarly to the male; segment 9 yellow on dorsum, 10 black.

Anal appendages short, conical, black. Vulvar scale robust.

Distribution.—The type comes from Singapore but it is by no means certain that the allotype female from Burma (Teneral and in poor condition) belongs to it, the probability being otherwise. The female, taken on Mt. Karen in May, has the paler yellow markings probably pale blue in the adult stage.

Drepanosticta Annandalei Fraser.

Drepanosticta annandalei Fras. Rec. Ind. Mus. Vol. xxvi. pp. 412, 413 (1924).

Male. Abdomen 32 mm. Hindwing 22 mm.

Head.—Labium brown; labrum, bases of mandibles and adjacent part of anteclypeus palest blue, the former narrowly bordered with glossy black; postclypeus and rest of head matt black; basal and 2nd segments of antennæ white; eyes olivaceous brown above, paler beneath.

Prothorax brownish white with a large black spot on each side; posterior lobe simple, rounded.

Thorax blackish brown on dorsum with the middorsal carina and upper part of humeral suture paler. Laterally white with a diffuse brown fascia traversing the sides obliquely as far as metepimeron.

Legs creamy white; femora on extensor surfaces stippled with black; tibiofemoral joints black.

Wings hyaline; pterostigma blackish brown, shaped similarly to that of *D. carmichaeli*; 16 postnodal nervures to forewings, 14 in the hind; *Riv+v* arising in continuation with the oblique nervure descending from the subnode; *ab* very oblique, arising from posterior border of wing somewhat distad of *ac*.

Abdomen creamy white laterally and beneath, black on dorsum, the black not extending to extreme base of segments but expanding apicad to form broad annules; segment 8 white or pale blue for its basal two thirds but the black of the apical third extending finely along the middorsal carina as far as base of segment; segments 9 and 10 black, unmarked with blue.

Anal appendages black, slightly longer than segment 10, the inferiors slightly shorter than superiors. Superiors broad at base, rotated on their long axis at the middle at which point they curve somewhat inwards and strongly downwards ; apices obtuse and slightly bevelled. Inferiors broad at base, then tapering, cylindrical, ending in an acute point.

Female. Abdomen 25 mm. Hindwing 20 mm.

Very similar to the male but abdominal segment 8 black for its apical half ; segment 9 with the basal two-thirds white (or blue) apical third black. Anal appendages short, conical, pointed, pale ; vulvar scale robust, not extending beyond end of abdomen.

Distribution.—Andamans only. Type in the Indian Museum from Mt. Harriet, 800 ft. South Andamans, taken in deep jungle at edge of a stream in December. Its simple black colour with white and blue markings serves to determine it from *D. carmichaeli* and *D. polychromatica* whilst the comparatively short abdomen will separate it from *D. viridis*. Its extremely simple anal appendages will distinguish it from *D. quadrata* as well as from other Malayan species of the genus.

In the original description I compared this species with *D. hilaris* from Burma, whereas *D. quadrata* was of course intended.

(*To be continued.*)

INDIAN NET-VEINED MIDGES OR BLEPHAROCERIDÆ

(INSECTA: DIPTERA).

BY

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(*With one plate and four text-figures*).

The Blepharoceridæ or Net-veined Midges are of special interest to a student of Animal Adaptations and Evolution. These insects comprise an archaic family of Nemocerous Diptera whose affinities are still a matter of conjecture. They are highly specialized for life in swift currents during all stages of their development. In the course of my work on torrential populations[1] I became greatly interested in the larvæ and pupæ of the Blepharoceridæ and have made a representative collection of the group at Dumpep and Shillong in the Khasi Hills, in the Teesta-Valley below the Darjiling Himalayas and at Dalhousie and Chamba in the Western Himalayas. Dr. A. L. Tonnoir[2] has worked out this collection and has come to the conclusion that the Blepharocerid fauna of India "is certainly the richest of the world in the number of Genera". He has described two new remarkable genera—*Horaia* and *Eulliponeura*. Dr. Tonnoir has expressed a hope that his paper "will stimulate the collectors in the Indian region to pay more attention to those interesting flies". It may be pointed out here that the Blepharoceridæ seem to be fairly well represented throughout India, for, a few specimens have been brought back by the Zoological Survey parties from the Nilgiris, the Simla Hills and Burma. No systematic collection has, however, been made in any part of India, except in the three regions mentioned above.

The object of this short note is to bring to the notice of likely collectors the general form and habitat of these interesting flies.

Of all the animals that inhabit the torrential streams of India the larvæ of the Blepharoceridæ are the best adapted to hang on to bare rocks in the most tumultuous situations. They "like the lip of a fall, the rocks of cascades, and the sides of a pot-hole in which the water is ever whirling and boiling".[3] They always

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[1] Hora, S. L., *Phil. Trans. Roy. Soc. London,* Series B, CCXVIII, pp. 171-282 (1930).

[2] Tonnoir, A. L., *Rec. Ind. Mus.,* XXXII, pp. 161-214 (1930).

[3] Kellog, V. L., "Diptera. Fam. Blepharoceridae". "*Genera Insectorum*", Fasc. LVI, p. 3 (1907).

HABITAT OF INDIAN BLEPHAROCERIDAE.

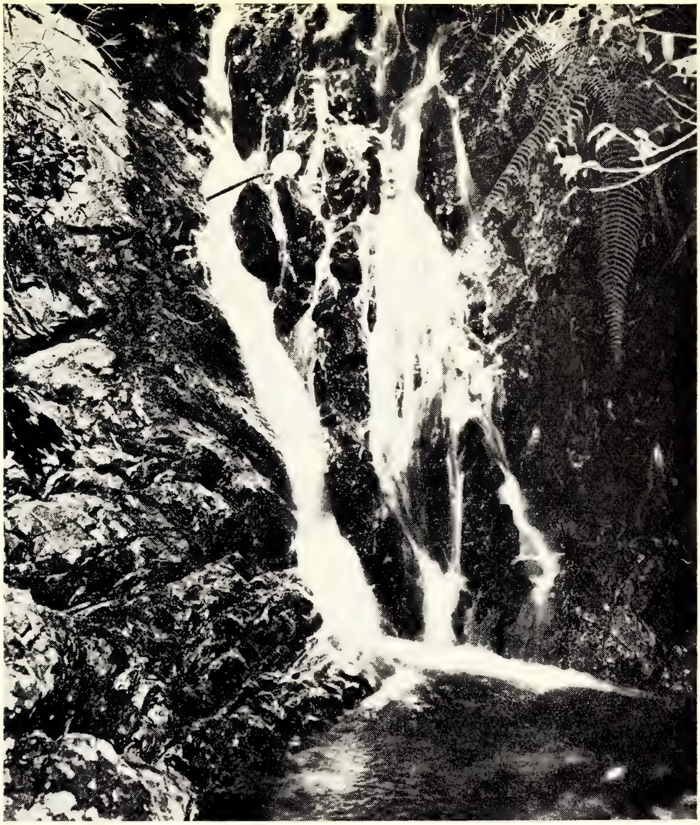

Fig. 1. A fall in the course of a small stream below Shillong-Cherrapunji Road ½ mile beyond Dumpep, Khasi Hills, Assam.

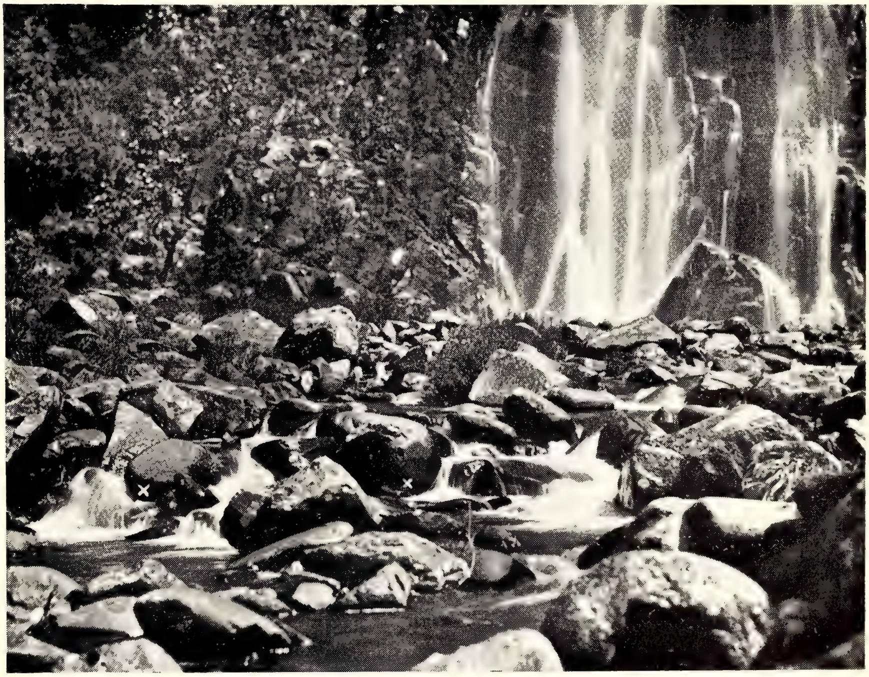

Fig. 2. Stream below Umdong fall near Dumpep, Khasi Hills, Assam.

D. Bagchi Photo.

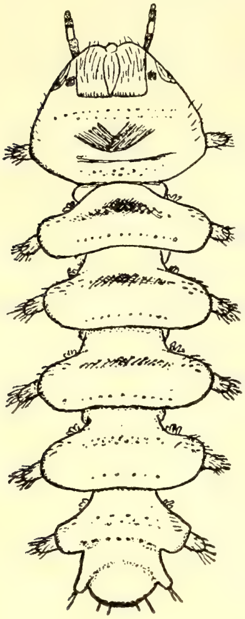

FIG. 1.
Larva H. (after Tonnoir).

live on bare rocks (not overgrown with slimy matter) but naturally the habitat of the different species is different. Some live on stones and rocks forming the bed of a torrent, others prefer lips of falls, while there are some that live on rocks at the base of falls over which water falls with a tremendous crash. Usually the larvæ live in large number in one place and form black patches on the rocks. Each larva is a small animal only a few millimetres in length, oval in outline with the body slightly depressed. By virtue of half a dozen ventral suckers, each of which is capable of powerful and independent attachment to the stones, these larvæ manage to live in the swiftest part of the current. The suckers have become so important that the body has become segmented secondarily, so that the major divisions of the body conform to the suckers and not to the original body segments. In some forms (fig. 1) the body is constricted between these divisions and the lateral appendages are well-marked, while in others a regular limpet-shaped form is attained (fig. 2).

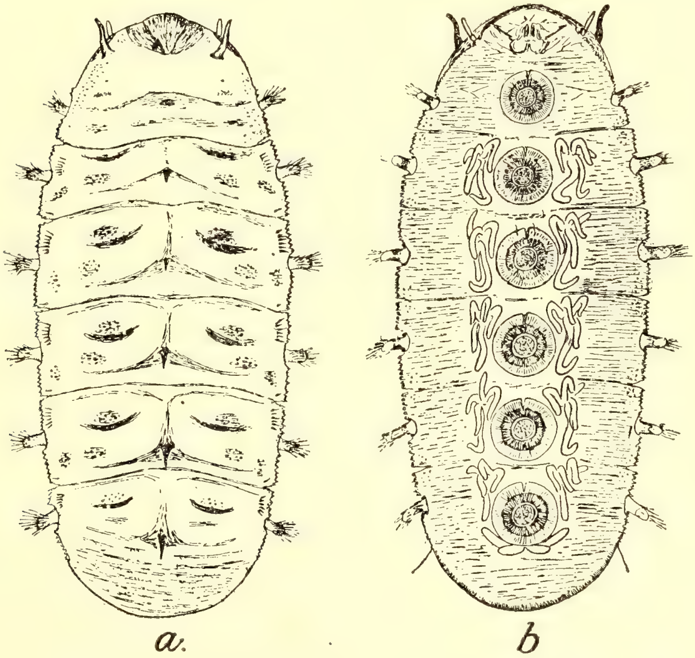

FIG. 2. Dorsal (*a*) and ventral (*b*) views of Larva R1, of *Horaia* (after Tonnoir).

A pupa (fig. 3) of the Blepharoceridæ is roughly oval in outline, is strongly convex on the dorsal surface and flat on its ventral surface by which it adheres. Each pupa is fastened to the rocks by six pads, three on each lateral margin of the ventral aspect of the abdomen. The pupæ, like the larvæ, are found closely clustered together with the head pointing downstream. According to most writers pupæ live in similar situations as the larvæ but Hubault[1] has observed them actually preferring swifter currents than those in which the larvæ live. My observations are different. About the time of pupation the larvæ seek comparatively sheltered places and generally pupate in such situations where they are kept moist either by the dribbling of the water or by the spray of a fall. I have collected pupæ from the under side of the rock forming the lip of a fall and from the face of a cascade behind the column of falling water. In a small stream flowing through the Teesta Bazaar, Mr. Hodgart, the field-collector of the Zoological Survey, obtained pupæ from the exposed surfaces of rocks and stones living in similar situations as the larvæ.

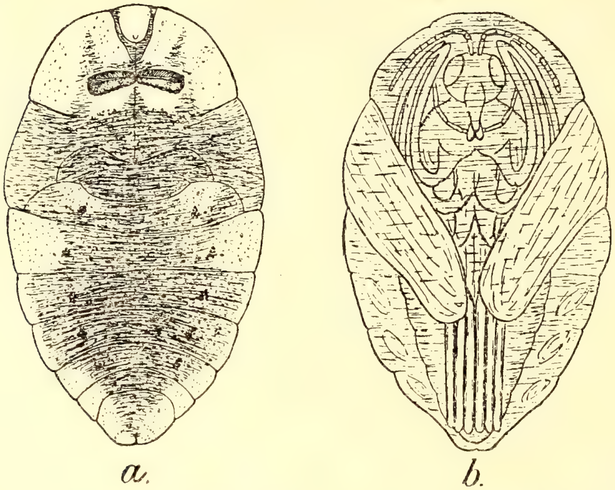

FIG. 3. Dorsal (*a*) and ventral (*b*) views of Pupa I of *Euliponeura horai* Tonnoir (after Tonnoir).

Dr. Tonnoir has sent me the following valuable information regarding the habitat of the Blepharocerid pupæ studied by him under natural conditions: "I have always found *Edwardsina* pupæ under the water, *Neocurupira* and *Peritheates* pupæ can live right under the water as evidenced by breeding them in aquarium; but the latter are found sometimes out of the water. The same applies to *Paracurupira*; *Apistomyia* were found mostly out of the water but in New Zealand and Tasmania the level of the mountain creeks is varying so much even in summer (especially on the west coasts) that the pupæ may be from one day to the other completely submerged or well above the water level and sometimes not even kept moist by the spray''.

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[1] Hubault, E., *Bull. Biol. France Belgique, Supp.*, IX, p. 304 (1927).

It is clear from the above that a collector must look for the pupæ in all kinds of possible "niches" in close proximity to the falls where the larvæ live.

I have not been very successful in collecting the adult flies of this family. "The imagines have very long, slender hind legs, and cling to the wet rocks with all six legs spread widely out. Their wings are held out at right angles to the body and in line with one another; this habit enables the collector at once to distinguish a Blepharocerid from various forms of Tipulidæ which frequent similar situations, but which always rest with the wings folded down the abdomen''[1]. Another character, by which a collector can distinguish flies of this family, is the secondary net-veining

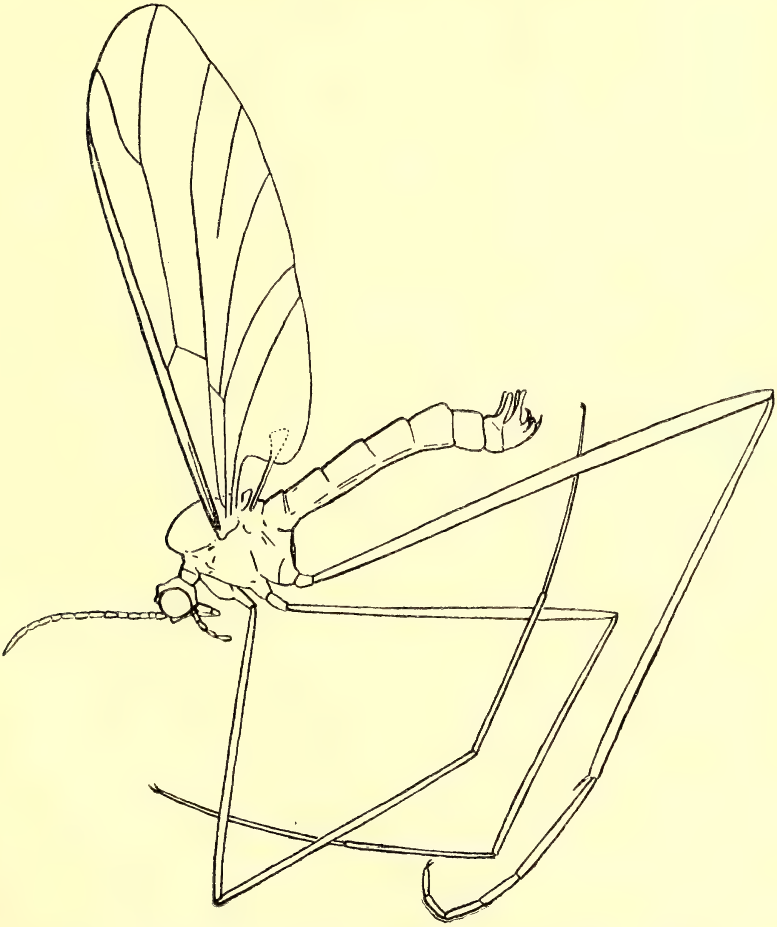

FIG. 4.—Male of *Euliponeura assamensis* Tonnoir (after Tonnoir).

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[1] Tillyard, R. J., *Australian Zoologist*, II, p. 159 (1922).

and the petiolate condition of the wing. According to Tillyard the flies are very tame and "can be easily caught either with a forceps or with the fingers, though they should be approached without unnecessarily irregular movements". I collected two specimens of *Apistomyia* drifting up stream in the evening along the rapids above the falls of the Punj-pul stream at Dalhousie. A few flies—*Blepharocera, Horaia* and *Euliponeura* (fig. 4)—were collected by sweeping among overhanging plants near waterfalls in the Khasi Hills.

So far as my experience goes these interesting insects can be collected in India at all times of the year, but spring is believed to be the most favourable time.

EXPLANATION OF PLATE

Fig. 1.—*A fall in the course of a small stream below Shillong-Cherrapunji Road ¼ mile beyond Dumpep, Khasi Hills, Assam.*

Blepharocerid larvæ were found in great abundance on such portions of the vertical rock over which the water fell. Pupæ clustered together on slightly raised portions of the rock, such as the one indicated by the position of the small net in the photograph, where they were kept moist by a spray from the waterfall. A few flies were netted by sweeping among the overhanging bushes.

Fig. 2.—*Stream below Umdong fall near Dumpep, Khasi Hills, Assam.*

Blepharocerid larvæ were very common on sides of rocks which formed rapids and lips of small falls. Clusters of pupæ were found above the level of water on the sides of rocks marked with X. In such situations they were being constantly washed by the eddies of the current and kept moist by spray.

THE PROBLEM OF EVOLUTION.

BY

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ANNUAL ADDRESS DELIVERED BEFORE THE ASIATIC SOCIETY
OF BENGAL, FEBRUARY 1931.

PART II.

(*With a plate*).

(*Continued from page* 131 *of this volume.*)

THE TREND OF EVOLUTION UNDER NATURAL CONDITIONS

The theory of evolution is based on one proved fact and one assumption, namely (1) that living matter exhibits definite variations, whether these be of the nature of small and gradual alterations or of larger and more obvious changes that may be inherited and are termed mutations; and (2) that nature has exercised and presumably still exercises a selective choice among living organisms as a result of changing conditions of time and space combined with competition. I do not propose to discuss here the causes of these variations and mutations but it seems to me that such departures from the normal must ultimately be the result of external conditions that act on the organism, and, further, we must bear in mind that the primary cause may have acted on the immature or larval stage of an animal and not on the adult, and that the effect may not become visible until the next or possibly even the 2nd generation. Garstang[1] claims as examples of this early action that the Order Gastropoda in the Mollusca originated by a change, to wit, the torsion of the body, that first arose in the free-swimming larval stage of development; and that the differentiation of such genera as *Emarginula* and *Fissurella* were equally brought about by a larval mutation, these changes being handed on to the adult. Willey[2] has also emphasised the view that "Larvæ are the vehicles of the future rather than the relics of the past". In any case varieties or mutations arise from the parent stock and according to the Darwinian theory their survival will depend on the value or otherwise of the alteration; if the variation is an advantage to the species then it will be preserved. Darwin[3] himself remarks, "It is, as I can see now, probable that all organic beings, including man, possess peculiarities of structure, which neither are now, nor were formerly, of any service to them, and which, therefore, are of no physiological importance. We know not what produces the numberless slight differences between the individuals of each species . . . ; but each peculiarity must have had its efficient cause. If these causes, whatever they may be, were to act more uniformly and energetically during a lengthened period, the result would probably be not a mere slight individual difference but a well-marked and constant modification though one of no physiological importance.'' Twice in thirteen lines Darwin asserts that these changes may be of no physiological importance; but can any change, accompanied as it must be by other changes in the complete organism, be of no importance, physiologically or otherwise? The advocates of the Darwinian theory of Evolution and those of the Mutation theory appear at first sight to be in the main in complete opposition in their views regarding the effect of environment on the race. According to Darwin, animals are always tending to vary and if the variation is beneficial then external surroundings will by selection perpetuate and even intensify such modification, till we ultimately get a new species established. The Mutationists, however, hold the view that the change of structure or function is inherent in the egg and the effect of environment on a favourable mutation will be to fix it and eliminate all those other forms that tend to vary from the mean. These views regarding the effect of the surroundings on the individual are, however, not so diametrically opposed as at first sight they appear to be; but neither view formulates any ultimate cause for the variation or mutation, or, in other words for the actual evolution of new forms.

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[1] Garstang, W., 1928. "Origin and Evolution of Larval forms." British Association, Section D. Zoology. Glasgow.

[2] Willey, A., 1911. *Convergence in Evolution,* p. 41. London.

[3] Darwin, Charles, *Descent of Man,* pp. 61, 62. 2nd Edition, 1896.

Evolution, as I understand it, is the response of the living organism to the outside influences that constitute its environment and this response may be in one of two directions. In the early stages of evolution or in the early stages of development in those animals in which evolution has already advanced to a considerable degree and which we in consequence term higher animals, the actual external conditions themselves appear to have acted upon the organism, producing changes in the genital cells and thus giving rise to forms that differed from their parents and, if those influences affected the chromosomes of the nucleus of the germ cells, the change in bodily form was inherited and we get what is termed a mutation. Bather[1] in his address to the Geological Society in 1928 asks ''Why do mutants so often assume the same characters as the adaptive modification? Does the influence that produces the modification also induce a change in the germ, and, if so, why is that change in the same direction as the modification?'' He suggests that there is some physico-chemical factor in the body that will be found to be capable of producing the same effect on the germ cells as on the body itself; but without actually adopting this view, though it is, I think, extremely probable, we must not overlook the fact that while changed surroundings *may* produce mutations in a number of different directions, it is only those that are of direct utility to the animal or, in other words, those that approximate to the modification that will be able to survive and thus become known to us either by their presence in animals in the living state, or by their presence as fossils in the various strata in sufficiently large numbers to have ensured their subsequent discovery and thus to afford the proof that at one time they did survive the changes in their surroundings. Whatever the actual process may be, there can be but little doubt that there is a close connection between the surroundings and the bodily characters. As Baker[1] remarks, "Some Zoologists—especially Ecologists—may affirm that the environment, in directing evolution, does in fact cause the change, as for example, when a normal river or creek species is forced to inhabit a lake, and in a sense this may be true, the changed environment *compelling* the organism to change its structure so that it may be in harmony with the changed conditions." My colleague, Dr. Hora[2], has made a special study of the similarity of structure in those animals that inhabit torrential streams, and the same close resemblance can be seen in those animals that have respectively adopted an arboreal existence, a borrowing form of life, or an aquatic habitat, etc. A comparatively short change of environment may be sufficient to produce a similar change in different animals. During the last year Le Souef[3] has given a very interesting account of the changes that have taken place during the last 60 years in certain species of Wallaby that were introduced from Australia into Kawan Island, near Auckland, New Zealand; four species were introduced and in three of these exactly the same evolutionary changes have now taken place; the fur has become longer and more silky, the colouration is darker and the markings have become more pronounced. The fourth species is, as yet, unchanged. Exactly similar changes have occurred in Opossums that were introduced into New Zealand; here also the fur is longer, more silky and less dense and these changes are so marked that New Zealand skins can be distinguished among thousands of others that are offered for sale. We have here a very clear instance of identical changes being caused in certain characters of species belonging to different Sub-orders of the Marsupialia as a result of introduction into the same conditions of life.

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[1] Bather, F. A., 1928. ''The Fossil and its Environment.'' Annual Address to the Geological Society, London.

In the present state of our knowledge it is not, however, always possible to correlate similar variations in different species with similar changes in the environment; as an example I may cite the change from a distome form to a monostome in some of the larvæ of the Digenetic Trematodes.[1] In every case these larval forms pass through a stage, known as the Cercaria, in which they leave their first host, a Mollusc, and take to a free-swimming life. So far as one can judge, there can be but little difference in their surroundings and yet in five or six instances there has occurred, quite independently, a suppression of the posterior or ventral sucker. A somewhat similar phenomenon, met with in certain other groups of the animal kingdom, is the progressive variation, or the waxing and waning of what Metcalfe[1] terms "trends." These trends may arise in certain families and are not, apparently, directly connected with the external surroundings though their inception must, I think, have some ultimate external cause. The examples that Metcalfe quotes are certain planktonic organisms or intestinal parasites, both of which live under conditions as stable as one is likely to find anywhere in nature. These trends are tendencies to vary in a particular direction and may possibly be the result of a physiological mutation, but even so they appear to have periodic fluctuations, rising to a maximum and then waning again; and they may for a time even be suppressed altogether but only to appear again later. Such trends act and behave like other characters of the body; and, like many other characters, they tend to appear in subsequent stages of evolution at an ever earlier stage of development and in some instances may, as a result of this, actually become harmful to the race.

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[1] Baker, F. C., 1928. "Influence of a changed environment in the formation of new species and varieties." *Ecology*, Vol. ix, No. 3, p. 271.

[2] Hora, S. L., 1930. "Ecology, Bionomics and Evolution of the Torrential fauna, with special reference to the organs of attachment." *Phil. Trans. Royal Soc. London.* Series, B. Vol. 218, pp. 171-282.

[3] Le Souef, 1930. *Australian Zoologist*, Vol. vi, p. 111. (I have not been able to refer to this paper. R.B.S.S.)

[4] Sewell, R. B. S., 1930. "The Evolution of the Excretory System in certain groups of the Furcocercous Cercariae." *Rec. Ind. Mus.*, Vol. xxxii (in the Press).

Within recent years it has been shown that changes in environment may be accompanied by and in all probability themselves produce physiological alterations in the body without causing any corresponding morphological change, except possibly, one of bodily size; in such cases even a detailed and careful examination fails to reveal any difference in the structure of the various parts of the organism, even the proportional sizes of the various parts remaining the same. We thus get the formation of physiological or, as they have been termed, Biological races within the limits of the same single morphological species. Such races may be induced by a variety of causes, such, for instance, as:

(1) changes in the external temperature conditions.

Individuals of a species may become acclimatised to either high or to low temperatures and yet be unable to stand any sudden change. In such cases individuals adapted to higher temperatures are unable to inter-breed with those living at a lower temperature. Exactly similar changes may be induced by

(2) changes in the pH concentration of the surrounding medium, or,

(3) changes in Salinity.

Again, we may get changes in the physiological conditions of the animal itself, as for instance—

(4) differences in the time of ripening of the genital organs, or differences in habits during the breeding season, or,

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[1] Metcalfe, M. M., 1928. "Trends in Evolution: A discussion of data bearing upon 'Orthogenesis' ". *Journ. of Morphology and Physiology*, Vol. xlv, p. 1.

(5) in the nature of the food and the resulting differences in the vitamine supply that may cause a difference in the bodily size.

Any of the above causes may prevent the fertilisation of the females of one race by the males of another, and we should thus get a physiological isolation, the effect of which will be quite comparable, so far as the production of new species is concerned, to that produced by spatial isolation.

There is also a growing mass of evidence that, quite apart from any possible effect that it may have on the germ cells, an alteration in the environment, using this term in its widest sense, may produce an effect on the body as a whole and also on certain groups of cells or organs within the body and may thus affect the future structural and physiological condition of the organism. In this connection it is interesting to note the very small limits of the physical conditions within which life is possible. The known range of the thermometer extends from -273° C to the upper extreme that lies far beyond the condition known as white heat, approximately 2000° C; yet living organisms can only exist between the ranges of 0° and 100° C. As Coleman[1] has pointed out, liquid water is essential for the continuance of life. In some of the lower organisms the individual can withstand being frozen for a short time, and in the higher or warm-blooded animals their bodies can for varying periods withstand an exposure below 0° C, but only because the body retains its own temperature and thus prevents the water in the system from freezing; water as a gas and water as a solid will not serve the purpose of life, it must be in a liquid condition. Doubtless changes in the external conditions can be met by living organisms in a variety of ways and in my Presidential address to the Indian Science Congress last month I put forward evidence to show that either external conditions, using the term in its widest sense, or the internal conditions of the parent may so affect the developing animal as to cause the appearance of new characters. Many of these changes are small and of but little concern to the animal; yet, by the summation of such characters brought about by natural selection, we may ultimately produce a very marked change. Sewertzoff[2] has classified the evolutionary changes that occur in the animal kingdom into four groups:

(1) Aromorphoses, or changes of both the structure and function of organs or progressive evolution;
(2) Idio-adaptations, or specialised adaptations to changing surroundings;
(3) Coenogenesis or embryonal adaptations; and
(4) Degeneration.

These two latter groups of changes are of a somewhat specialised kind and I do not propose to consider them further; the other two seem to me to differ from each other in degree rather than in kind. In both cases they are the responses of the body to altered environment and in the case of the Aromorphoses, that led to the origin of the great groups of the animal kingdom, occurred for the most part, if not entirely, at those periods of the world's history when the earth itself was undergoing profound changes in its physical condition. There is among some zoologists and especially among those who have attempted to study the Psychology of the lower animals a growing tendency to regard the animal's own initiative as one of the most important factors in the evolution of the race, though some appear to me to press the argument too far. One cannot but admit that a change of function in an organ, such as Sewertzoff postulates in the ''aromorphoses'', must in many cases have been due to a large extent to the animal's own activities. The change from a simple branchial skeleton supporting the gill arches in the primitive chordate to a definite mechanism for capturing prey, with its upper and lower jaws, must very largely have depended on the efforts of the animal and its use of the anterior arches as a prehensile mechanism; again, in the torrent-inhabiting forms, the development of a flattened body or prehensile claws, that enable the animal to lie close against the surface of, or to cling to, a rock and thus allow the rush of water to pass harmlessly by, could only have possessed survival value if the animal had adopted a rock-frequenting habit, and it is possible that in a dim and smaller degree the same initiative was active in the production of new forms among the lowest animals.

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[1] Coleman, A. P., 1926. *Ice Ages. Recent and Ancient.* New York.

[2] Sewertzoff, H. N., 1929. "Directions of Evolution." *Acta Zoologica,* Vol. x, p. 59.

Bidder has recently pointed out that a small change in the animal's structure or physiology, that under normal conditions may be neither useful nor harmful, may, during the occurrence of a ''cataclasm'', become the deciding factor whether the possessor shall survive or not; and if these cataclasms are repeated, even if only at intervals of such immense length as 50,000 years, they will have a great effect on the preservation and in determining the character of the surviving fauna. Such cataclasms or rather cataclasmic periods seem to have occurred in the earth's history on five different occasions, in most cases associated with a definite Glacial Period, and at or closely following each successive cataclasmic period there was a considerable development and evolution of animal forms. In the accompanying chart I have attempted to show graphically the time in the history of the earth at which the great groups of the animal kingdom came into existence and you will at once notice how early many of these great groups made their appearance. The figure is based on a chart recently published by Matthew[1], showing the probable Geological period in which each of the main phyla arose, modified in places in accordance with the views of Chamberlin and Salisbury[2], while on the left hand side, the wavy line, showing the periods of instability of the earth's crust is taken from Dudley-Stamp[3]. Life probably began on the earth at some stage of the Eozoic or possibly even in the Azoic Era, though up to the present time the earliest

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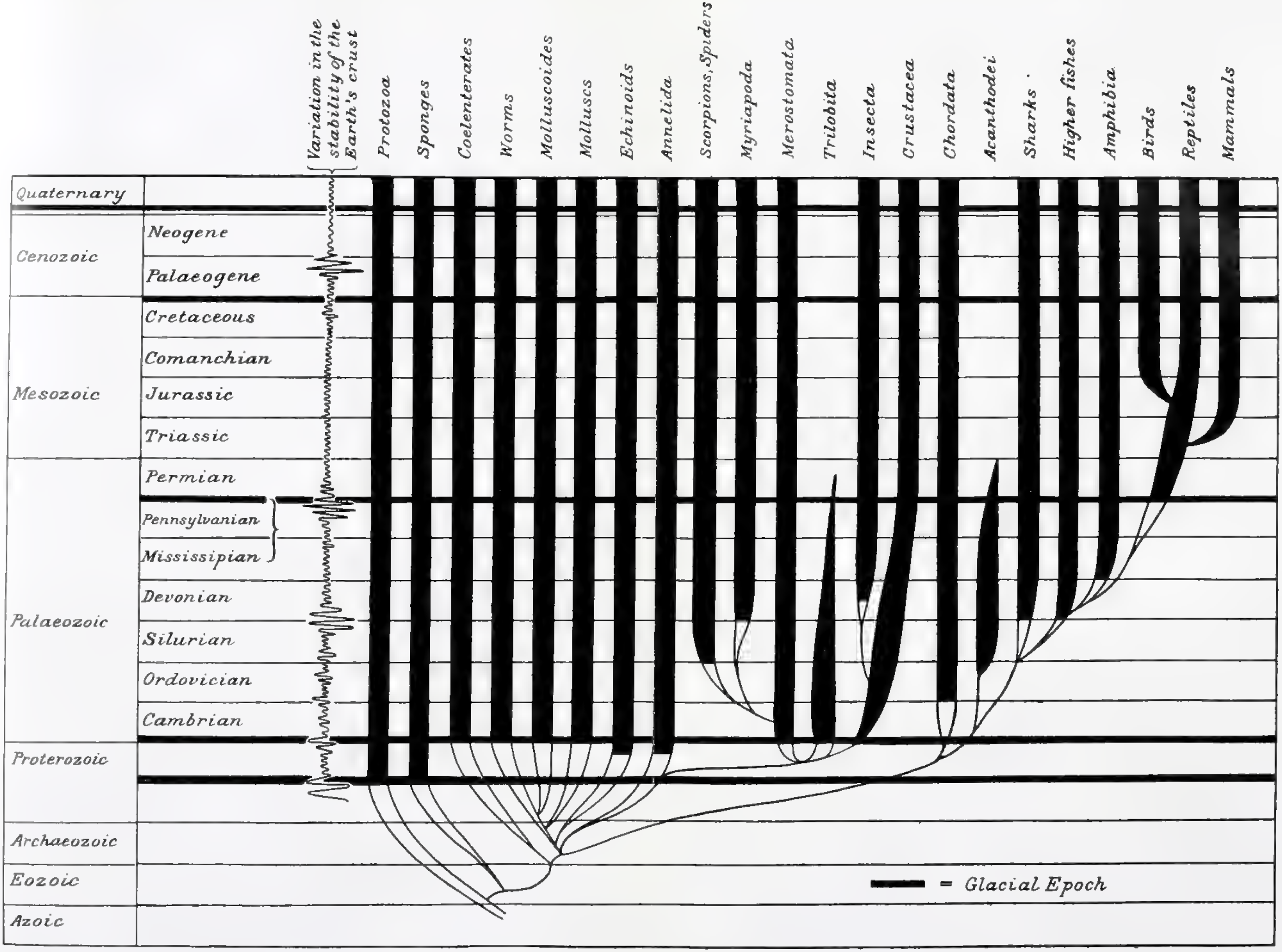
[1] Matthew, W. D., 1930. ''The Pattern of Evolution''. *Scientific American*, Sept., p. 192.

[2] Chamberlin and Salisbury, *Geology; Earth History*. London.

[3] Stamp, L., Dudley, 1923. *An Introduction to Stratigraphy*, Fig. 4, p. 19. London.


Variation in the stability of the Earth's crust
Protozoa
Sponges
Coelenterates
Worms
Molluscoides
Molluscs
Echinoids
Annelida
Scorpions, Spiders
Myriapoda
Merostomata
Trilobita
Insecta
Crustacea
Chordata
Acanthodei
Sharks
Higher fishes
Amphibia
Birds
Reptiles
Mammals
Quaternary
Cenozoic
Neogene
Palaeogene
Mesozoic
Cretaceous
Comanchian
Jurassic
Triassic
Palaeozoic
Permian
Pennsylvanian
Mississipian
Devonian
Silurian
Ordovician
Cambrian
Proterozoic
Archaeozoic
Eozoic
Azoic
= Glacial Epoch

fossils that have been discovered are from the Proterozoic Era. In the Huronian period of the Proterozoic Era we get the first great period of instability and glaciation, and immediately following this we find that by the end of the Proterozoic period evolution had advanced so far that the Protozoa, Sponges, Coelenterates, Echinoids, Annelid worms, Crustacea, Pteropods, and Molluscoides had all definitely made their appearance. At the close of the Proterozoic Era in the Precambrian period there was a second Glacial Epoch and immediately following this in the Cambrian we get evidence of the existence of Gastropod and Lammellibranch Molluscs, while in the periods that follow we find the existence of Cephalopods, Chordata, and Vertebrates in the form of Fish; while at the close of the Silurian period there is evidence of another period of instability of the earth's crust, though in this case unaccompanied by any glacial epoch, and we now find the remains of Crinoids, Reef-forming Corals, Arachnids (Scorpions, Spiders) and in the Devonian Period of Insecta and Amphibia. Following on the Carboniferous (Pennsylvanian) Period of the Palaeozoic came the third great glacial epoch again accompanied by a period of instability of the earth's crust and this is followed in the Permian by the appearance of Reptiles, while the Triassic and Jurassic Periods of the Mesozoic saw the commencement of the Birds and Mammals. From this stage there has been no new appearance of Classes or Orders and for the most part evolution has been limited to the appearance of new genera or species. The effects on the animal population of the globe of this Carboniferous glacial epoch are summed up by Coleman[1] in the following words: "The Palaeozoic, the time of ancient life, ends with the Permian, when most of the formerly dominant types of living beings disappear or lose their importance, leaving the way open for new types to take their place. This is true of land and sea and air. It was too serious an ordeal for many creatures adjusted to warm waters, and we find that Trilobities vanish, Corals and Brachiopods diminish greatly and few of the many primitive sharks of the Palaeozoic seas survive. The antiquated Ganoid fish with bony scales or plates almost disappear. In their place come the more modern and adaptable molluscs, Ammonites, bony fish, and great marine reptiles. On the land the giant spore-bearing plants, horse-tails, ground pines and tree ferns lose their supremacy and give place to Conifers and Cycads, the forerunners of Mesozoic forests. Among the Cryptogamic trees, there were many strange insects, including forms like dragon-flies with a two-foot spread of wings. The climax in size of the lower forms of plant and animal life, the spore plants and the insects, passed with the long winter of the Permocarboniferous Ice Age, leaving the way clear for the flowering plants and flying vertebrates, such as the Pterodactyls and the birds with teeth of the Mesozoic. On the land the small reptiles which survived the cold rapidly multiplied and expanded into the dinosaurs, which ruled the renovated continents after the Ice Age disappeared."

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[1] Coleman, A. P., 1926. *Ice Ages. Recent and Ancient.* New York.

Matthew[1] remarks "the period was a most important and critical one in the evolution of land life for it witnessed the first great expansion of land vertebrates and the origin, probably, of mammals, birds, and the principal orders of reptiles, including dinosaurs."

The huge dinosaurs were, again, in their turn, destroyed by or, at any rate, at about the time of the Glacial Epoch in Eocene times and finally it was the Glacial Epoch in Pleistocene times that gave Man his opportunity and led to the evolution of *Homo sapiens* from some primitive ancestor, such as *Homo heidelbergensis* or *Homo neanderthalensis*.

I would remind you that the date assigned to the first appearance of these great groups of the animal kingdom is dependent on the discovery of fossil forms in the various strata and it may be that future researches by geologists will throw the origin of some of these groups even further back. All that we can definitely state at the present time is that each of the groups are known to have been in existence at the period indicated. In this connection I may refer again to the recent publication by Matthew[1] who believes that nearly all the great groups originated at about the same time in the Precambrian era; Austin Clark[2] has recently suggested that the main evolutionary divisions took place at an even earlier stage. He postulates that "from the single cell life, at its very first beginnings, developed simultaneously and at once in every possible direction. All of the phyla or major groups seems to be a simultaneous development. From each one of them a separate evolutionary tree arose, growing upwards through the ages." He maintains that so far back as Cambrian Times, at least, the major groups of animals bore the same relationships to each other that they do to-day and moreover that this Cambrian era is much nearer to the present epoch than it was to the far distant time when life on earth began. Dr. Hans Przibram[3] throws the great changes in evolution even further back, and suggests that every species of Metazoan has been derived, independently of all others, from a distinct species of Protozoan. Whichever of these views be right there seems but little doubt that each successive Glacial Epoch or period of instability of the earth's crust has been responsible for less and less advance in the evolutionary scale. No great group has appeared since the Jurassic and Triassic Epochs, when the Mammals and Birds first arose from the Reptiles, and by attaining to the condition of Homoiothermy or warm-bloodedness were able to dominate all the other groups of the animal kingdom.

As Langdon Brown[4] has recently pointed out, "the most striking thing about protoplasm is its incessant urge to assert itself as strongly as its environment will permit. This is the real struggle for existence. . . The whole story of the multicellular organisms is one of mutual adjustments between the different tissues, each trying to do the best for itself within the limits of those adjustments. And, similarly, the individual composed of such tissues struggles to achieve the best it can within its environment, or to change into a more favourable one. The dipnoid fish, gasping for breath on the mud-flats and struggling with its spiky fins to reach the land, was, no doubt, actuated by the need to escape from the competition of life in the sea towards the abundant food-supply on the land. From that successful struggle all the land Vertebrates and ultimately man himself arose.'' A study of the changes that have been carried out in this process of evolution indicates that protoplasm and the animal can react in one of two ways; the first of these ways, and probably at the outset of evolution the only way, was for the animal to react to and with its surroundings. In the very early stages of life on the earth the temperature of living organisms was the same or nearly the same as that of the surrounding medium; similarly the fluids of the body originally possessed the same specific gravity as that of the surrounding fluid, and if, as we believe, life originated in the sea these early animals were exposed to an almost definite and constant salinity and to only slight changes of temperature and gas content, while owing to the permeability of the outer wall or ectoderm any changes in the surrounding medium were rapidly compensated by changes in the animal itself. But as evolution progressed, we find that this adaptability was given up and the animal began to react *against* its environment or perhaps one should say to insulate itself against environmental changes. Attention to this type of evolutionary process has been drawn recently by Wardlaw[1]. As he points out, if the environment becomes too dry, the animal will surround itself with an impermeable wall and will encyst. At a later stage with the formation of a body, the body fluids at first possessed the salinity of the medium in which the animal lived, namely, that of the sea in which they originated, and doubtless fluctuated in accordance with the slight variations in the external conditions, but with the development of an ectoderm, that prevented the diffusion of the body salts into the surrounding medium, any subsequent change in the condition of the outer medium was without effect. The osmotic pressure of the body fluids such as the blood is in lower animals the same or very nearly the same is that of the surrounding medium. In Elasmobranchs the osmotic pressure of the two fluids is practically identical. In the Teleosts we get, however, the commencement of a controlling mechanism, for in the Plaice the osmotic pressure of the sea-water may vary 74 per cent while the osmotic pressure of the blood varies by only 20 per cent whereas in the cod the osmotic pressure of the sea may vary in different localities by 69 per cent but that of the cod's blood only by 3 per cent. One result of this stabilisation of the characters of the body fluids was to render it possible for marine animals to migrate into fresh water. Still later came the power of preventing the outer surface from drying up and the ability to absorb oxygen from the air, and in consequence animals were able to leave a watery medium and take to dry land.

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[1] Matthew, W. D., 1923. "Recent Progress and Trends in Vertebrate Palaeontology." *Bull. Geol. Soc. Amer.*, Vol. xxxiv, p. 404.

[2] Austin H. Clark, 1930. "Zoogenesis" *Scientific American*, Aug., p. 104.

[3] Przibram, H., *Rev. Gen. Sci.*, Vol. xi, No. 10, p. 293. (I have not been able to refer to this paper. R.B.S.S.)

[4] Langdon Brown, W., 1930. "On Clinical Psychology" *St. Bartholomew's Hospital Journal*, Vol. xxxvii, No. 10.

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[1] Wardlaw, H. S. Halero, 1930. "Some Aspects of the Adaptation of Living Organisms to their Environment." Presidential Address, *Proc. Linn. Soc. N.S. Wales,* Vol. lv. P. I, p. viii.

This land migration was not limited to any one group of the animal kingdom. It has taken place independently in at least three of the great groups or Phyla. In the Mollusca the Pelecypoda have been able to invade fresh water, but up to the present time have not succeeded in populating the land. The Gastropoda, on the other hand, have been able to do so, and we now find numerous representatives that pass their whole existence out of water and are able to protect themselves in time of drought by closing the opening of their shell. The Cephalopoda, which are regarded as being the most highly evolved of the Mollusca, have throughout maintained their marine habitat. Again in the Arthropoda a number of Crustacea have taken to fresh water and some even to a terrestrial existence, though most still have to return to water for breeding purposes; the second and third great classes, the Insecta and Arachnida, are nearly all terrestrial and breathe air, though here again some have to pass through their early stages in water. It is in the Vertebrata that the greatest and most complete change of habitat has taken place. In the lowest class the fish are still essentially aquatic, though a few have developed accessory respiratory organs that enable them to breathe air. The Amphibia, as their name implies, frequent both a watery and a dry habitat, though here again their early life-stages are passed in water. The Reptiles, Birds, and Mammals are essentially land dwellers, though a few have again returned to an aquatic habitat.

Finally we get the stabilisation of the temperature of the body in both the Birds and Mammals, or the condition known as ''Homoiothermy''; formerly the body temperature varied with that of the outer air or water but its stabilisation in the warm-blooded animals not only rendered them comparatively impervious to the changes of the outer medium but, being stabilised at a moderately high temperature, enabled them to perform all the functions of the body at a much more rapid rate than could be done in animals whose temperature not only fluctuated but was frequently considerably lowered in conformity with that of the outer air or water. They thus have a distinct advantage over the cold-blooded animals. In this connection it is interesting to note that the mechanism of heat control is not so efficient in the lower mammals, Monotremes and Marsupials, as it is in the higher forms, and also is not so efficient in the young of these higher forms as it is in the adult; in *Echidna* a variation in the temperature[1] of 30° C results in a change of 10° C in the body temperature. In some of the higher vertebrates the warm-blooded condition is, however, not permanent, but is replaced by a cold-blooded state of ''poikilothermy'' during hibernation.

In the highest group of animals the Vertebrates and even in some of the Invertebrates this tendency on the part of the animal to cut itself off from its external surroundings has been carried even further and has been supplemented by various devices that especially protect the individual in the very early stages of its development. In the lowest organisms eggs were and are laid in water and possess only a thin and delicate membrane around them, so that they are directly affected by changes in the external surroundings. Exposure to air would cause their drying up and the consequent death of the embryo, while changes in temperature would alter the rate or character of development. Then came the stage when the eggs were surrounded by a thicker covering, chitinous in some cases or with a lime shell in others. Such a shell prevents evaporation, so that the eggs can now be laid on land and development be expedited by the effect of the sun's rays, while the calcareous shell still further serves to protect the embryo from such influences as ultraviolet rays[2]. Finally, animals tend to become viviparous and development occurs *in utero,* where the embryo is maintained in equable surroundings, completely protected from changes in temperature, salinity or other changes in the external conditions, since those of the parent remain constant. These changes, however, did not take place simultaneously with the alteration of the habit of the parent but followed, usually, at a later period, though in some cases it has taken place in animals that still inhabit their old ancestral environment, the sea. In the Elasmobranch fishes, for instance, the eggs are usually enclosed in tough chitinous egg-capsules, but in a few cases the process of intra-uterine gestation has been attained. In the Amphibia, while the lower forms still respire by gills, the higher are able to breathe air when adult, but they nearly all still lay their eggs, surrounded by a thin capsule and enclosed in a gelatinous matrix, in water, though some, such as the Java tree-frog, lay their eggs in a nest made of a rolled leaf. The Reptiles, however, acquired the method of enclosing their eggs in a thick chitinous shell, and were thus able to deposit them on land; and in certain cases the chitin of the shell is still further strengthened by the addition of calcium salts. The Birds enclose their eggs in a shell impregnated with calcium carbonate and have adopted the process of incubation, thus protecting the developing offspring from variations in temperature, and in all these cases, in addition to this provision of a protecting shell, the egg is supplied with a large amount of nutrient material or yolk, that enables the developing young to pass a considerable time within this protection and to reach a comparatively advanced stage of development before it has to become exposed to the varying character of the external surroundings. Finally, the Mammals have evolved the method of intra-uterine gestation, though here again the process was somewhat delayed, for the most primitive mammals, the Monotremata, still lay eggs, while in the Marsupials intra-uterine gestation is extremely short, the young embryos being transferred to the Marsupial pouch. The result of this is that there has throughout been a steadily progressive protection of the developing embryo from its external surroundings, so that environmental

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[1] Pearse and Hall, 1928. *Homoiothermism,* p. 91, New York.

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[1] Hinrechs, Marie A., 1927. "Modification of development on the basis of differential susceptibilities to radiation." *Journ. Exper. Zool.,* Vol. xlvii, p. 309.

changes can no longer reach the embryo at that stage of its existence in which it is most, if not only, susceptible to such influences.

In a similar manner the introduction into the body of any substance is, if the introduction does not prove fatal, immediately counteracted by the production in the body of a substance that can neutralise the effect of the foreign materials; thus the introduction of an acid causes the production of an alkali, a toxin is met by the production of an anti-toxin, etc. In a number of cases, if not in all, the body overdoes the process, so that not only is the toxin neutralised but a superfluity of the anti-toxin is produced so that subsequent poisoning by the same toxin becomes more difficult or impossible, and this effect appears in some degree to be transmitted to the offspring.

It thus appears that throughout the later stages of evolution the animal has been steadily cutting off both itself and its offspring from its external surroundings and thus has equally throughout its whole life been cutting itself off from just those influences that in times past were responsible for the origin and gradual development of new forms and higher races. Wardlaw[1] concludes his address as follows: "We have in man, then, the most perfect adaptation to environment shown by any form of life. So great is his power of modifying his surroundings, and so rapidly is this power increasing that it would seem that further adaptation of his physical structures has become unnecessary." I would, on the other hand, be inclined to postulate that man has, or in the very near future will have, rendered himself so independent of his environment that this will no longer be able to affect his physical characters and that if there is to be any further evolution, this must be the result of his own mental processes.

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[1] Wardlaw, H. S. Halero, 1930. "Some Aspects of the Adaptation of Living Organisms to their Environment." Presidential Address, *Proc. Linn. Soc. N.S. Wales,* Vol. lv, Pt. I, p. viii.

ON A SMALL COLLECTION OF FISH FROM THE STREAMS IN THE BILLIGIRIRANGAN HILLS (S. INDIA).

BY

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(Published with the permission of the Director, Zoological Survey of India.)

This note deals with a small collection of fish made by Mr. R. C. Morris in the various streams in the Billigirirangan Hills on the Mysore-Coimbatore border in South India at altitudes varying from 2,500 to 5,000 feet. The collection was made at the request of Dr. S. L. Hora through the courtesy of the Bombay Natural History Society and recently sent to the Zoological Survey of India for identification. I am thankful to Dr. Hora for the opportunity of studying these fishes.

The collection comprises eight different species belonging to the families Cobitidæ, Cyprinidæ and Ophicephalidæ. All the species are known to occur in South India, and, except for a few on which notes are given below, do not call for special remarks. Mention must, however, be made of the excellent state of preservation of the material as a result of which the natural colouration of the different species is admirably preserved.

The details of localities, Kanarese local names, etc., are quoted *verbatim* from the original notes of Mr. Morris. The local names, however, are not meant to be absolutely correct, for, the collector himself remarked that he "cannot vouch for the correctness of the names."

Lepidocephalichthys thermalis (Cuv. *et* Val.).

1846. *Cobitis thermalis*, Cuvier et Valenciennes, *Nat. Hist. Poisson*, XVIII, p. 78.
1878. *Lepidocephalichthys thermalis*, Day, *Fish. India*, p. 610, pl. lv. fig. 3.
1927. *Lepidocephalichthys thermallis*, Rao & Seshachar, *Half-yearly Journ. Mysore Univ.*, I, No. 2, p. 10.

The height of the body is contained from 6 to 6½ times in the length of the body excluding the caudal fin. The origin of the ventrals is vertically below the first or the second branched ray of the dorsal fin.

The upper portion of the body is clouded with irregular black spots and blotches. In fairly grown-up specimens there are from 9 to 10 blackish bands along the back. Along the lateral line, there is a series of squarish black marks. The lower portion of the body is devoid of pigmentation. The fins, except the dorsal and the caudal, are diaphanous. Both the dorsal and the caudal fins have from 4 to 5 black curved bands. In some cases, these bands are broken up into irregular dots. A deep black spot at the base of the upper lobe of the caudal fin is present in all the specimens.

The species is known to inhabit the bottom mud or sand of rivers and ponds where it usually lies buried. Sundara Raj [1] has observed how this fish dives into the sand at the bottom of an aquarium. He further remarked that the "branchial respiration appears to be insufficient in this loach. In an aquarium, it grows restless at various intervals and rises to the surface to take air, which is apparently swallowed, consequently it lives for a long time out of water."

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[1] Sundara Raj, B.—"Notes on Fresh-water Fish of Madras." *Rec. Ind. Mus*, XII, pp. 261-262, (1916).

Nine specimens varying from 30 to 45 mm. in length were collected. The species is " found in all streams, in evergreen sholas and deciduous jungle and bamboo scrub below all elevations."

"*Murralli*" is the local Kanarese name of this loach.

Nemachilus striatus Day.

1867. *Nemachilus striatus*, Day, *Proc. Zool. Soc. London*, p. 347.
1878 *Nemachilus striatus*, Day, *Fish. India*, p. 617, pl. cliii, fig. 8.

This species was originally described by Day from Wynaad at 3,000 ft. elevation, but his description of the species is so inadequate, and the Indian species of the genus *Nemachilus* are in such a state of confusion at present that it is difficult to be certain about the specific identity of this fish. As Dr. S. L. Hora is already tackling the problem with a view to definitely define the specific limits and characters of the different species, I refrain from giving a detailed description of *N. striatus*, but provisionally refer the South Indian specimens to this species.

There are 10 to 12 vertical black bands along the sides. The dorsal fin is of an orange colour with two black bands. The characteristic black band at the base of the caudal fin is present in all the specimens.

The fish is represented in the collection by three specimens varying from 32 to 37 mm. in length. It is " found in all streams at eastern foot of hills (elev. 3,000 ft.), place—Mavatur, name of stream—Bellaji Halla. Stream heavily shaded."

The Kanarese call this loach "*Kull-koorchi*".

Nemachilus evezardi Day.

1878. *Nemachilus Evezardi*, Day, *Fish. India*, p. 613, pl. cliii, fig. 11.
1927. *Nemachilus evezardi*, Rao & Seshachar, *Half-yearly Journ. Mysore Univ.*, I, No. 2, p.11.

The length of the head is contained from 5 to $5\frac{1}{2}$ and the height of the body from 6 to $6\frac{2}{3}$ in the length of the body excluding the caudal fin. The eyes are small and are about two diameters from the tip of the snout. The width of the inter-orbital space is almost equal to the length of the snout. The pectoral fins are shorter than the head. The nasal barbels are longer than the diameter of the orbit and almost reach the anterior fourth of the eyes.

The colouration is a faint olivaceous green with a number of vertical black bars and blotches irregularly distributed.

The species is represented in the collection by six well-preserved specimens varying from 35 to 42 mm. in length. They are " found in rocky streams at eastern foot of hills (elev. 3,000 ft.), place—Mavatur, name of stream—Bellaji Halla. Stream heavily shaded."

The Kanarese do not apparently distinguish this species from *N. striatus* as both the species are locally known as "*Kull-koorchi*".

Garra sp.

There is a single specimen about 30 mm. long which appears to agree in all essential characters with *G. lamta* (Ham. Buch.), but since all immature forms of *Garra* show a wide range of variability in respect to specific characters, I refrain from referring it to any definite species.

The specimen was found with the two species of *Nemachilus* referred to above and collected in the " rocky stream at eastern foot of hills (elev. 3,000 ft.) place—Mavatur, name of stream—Bellaji Halla. Stream heavily shaded."

Barbus dorsalis (Jerdon).

1849. *Systomus dorsalis*, Jerdon, *Madras Journ. Lit. & Sci.*, XV, p. 314.
1878. *Barbus dorsalis*, Day, *Fish. India*, p. 573, pl. cxlii, fig. 2.
1916. *Barbus dorsalis*, Sundara Raj, *Rec. Ind. Mus.*, XII, p. 255.

The species is represented in the collection by a single young specimen about 45 mm. long excluding the caudal fin. The dorsal fin is inserted slightly in advance of the ventrals and is situated nearer to the tip of the snout than to the base of the caudal fin. There are two prominent black spots, one each at the base of the dorsal and caudal fins. These spots are often absent in adult individuals. The upper portion of the body is dusky, and the bases of the scales are blackish. The belly is yellowish white.

The species is common " in all small streams (elev. 3,000 to 5,000 ft.) in shola, deciduous and scrub jungles."

" *Kull-kooni* " is the local Kanarese name of this fish.

Rasbora daniconius (Ham. Buch.).

1822. *Cyprinus daniconius & anjana*, Hamilton Buchanan, *Fish. Ganges*, pp. 327-329, 391, pl. xv, fig. 89.
1878. *Rasbora daniconius*, Day, *Fish. India*, p 584, pl. cxlvi, fig. 2.
1929. *Rasbora daniconius*, Prashad & Mukerji, *Rec. Ind. Mus.* XXXI, p. 203.

The diameter of the eyes is contained from 4 to 4½ times in the length of the head; they are 1½ to 1⅔ diameters apart. The snout is almost equal to or slightly longer than the diameter of the eyes.

The dorsum is dusky. There is a black streak running along the median dorsal line from occiput to the insertion of the caudal fin. A very prominent transverse broad black band runs along the middle of the body from the snout to the base of the caudal fin. In some specimens, the scales of the upper portion of the body have dark edges. The fins are diaphanous.

The species is represented in the collection by eight specimens, the largest being 85 mm. in length. It is " found in a big stream at Punjur (western foot of hills) elev. 2500 ft. Partially shaded, rocky and sandy."

" *Sessillu* " is the local Kanarese name of the species.

Barilius gatensis (Cuv. *et* Val.).

1844. *Leuciscus gatensis*, Cuvier & Valenciennes, *Hist. Nat. Poisson*, XVII, p. 309, pl. 503,
1878. *Barilius gatensis*, Day, *Fish. India*, p. 592, pl. cxlix, fig. 2.
1931. *Barilius gatensis*, Mukerji, *Journ. Bombay. Nat. Hist. Soc.*, XXXV, p. 169.

Very thin maxillary barbels are present in all the specimens. The number of vertical black bars along the sides varies from 9 to 13. The dorsal fin has a triangular white outer area. The anal fin has a dark base. A bright pink band and a white outer streak run parallel to it. The pectorals and ventrals have similar pink bands. The cheek and the belly are of a light pink colour.

Seven well-preserved specimens were collected. The largest of the series is 88 mm. long. The species was found in (i) " rocky stream at eastern foot of hills (elev. 3,000 ft.), place—Marealut, name of stream—Bellaji Halla. Stream heavily shaded ", and (ii) " in a big stream at Punjur (western foot of hills), elev. 2,500 ft. Partially shaded, rocky and sandy ".

" *Genday* " is the local Kanarese name of this fish.

Ophicephalus gachua (Ham. Buch.).

1822. *Ophiocephalus gachua*, Hamilton Buchanan, *Fish. Ganges*, pp. 68, 367, pl. xxi, fig. 21.
1878. *Ophiocephalus gachua*, Day, *Fish. India*, p. 367.
1929. *Ophiocephalus gachua*, Prashad & Mukerji, *Rec. Ind. Mus.*, XXXI, p. 215.

Two half-grown specimens were " found in a big stream at Punjur (western foot of hills) elev. 2,500 ft. Partially shaded, rocky and sandy."

" *Kworamin* " is the local Kanarese name of the species.

NOTES ON INDIAN HAWKMOTHS.

BY

LT.-COL. F. B. SCOTT, I.A., F.E.S.

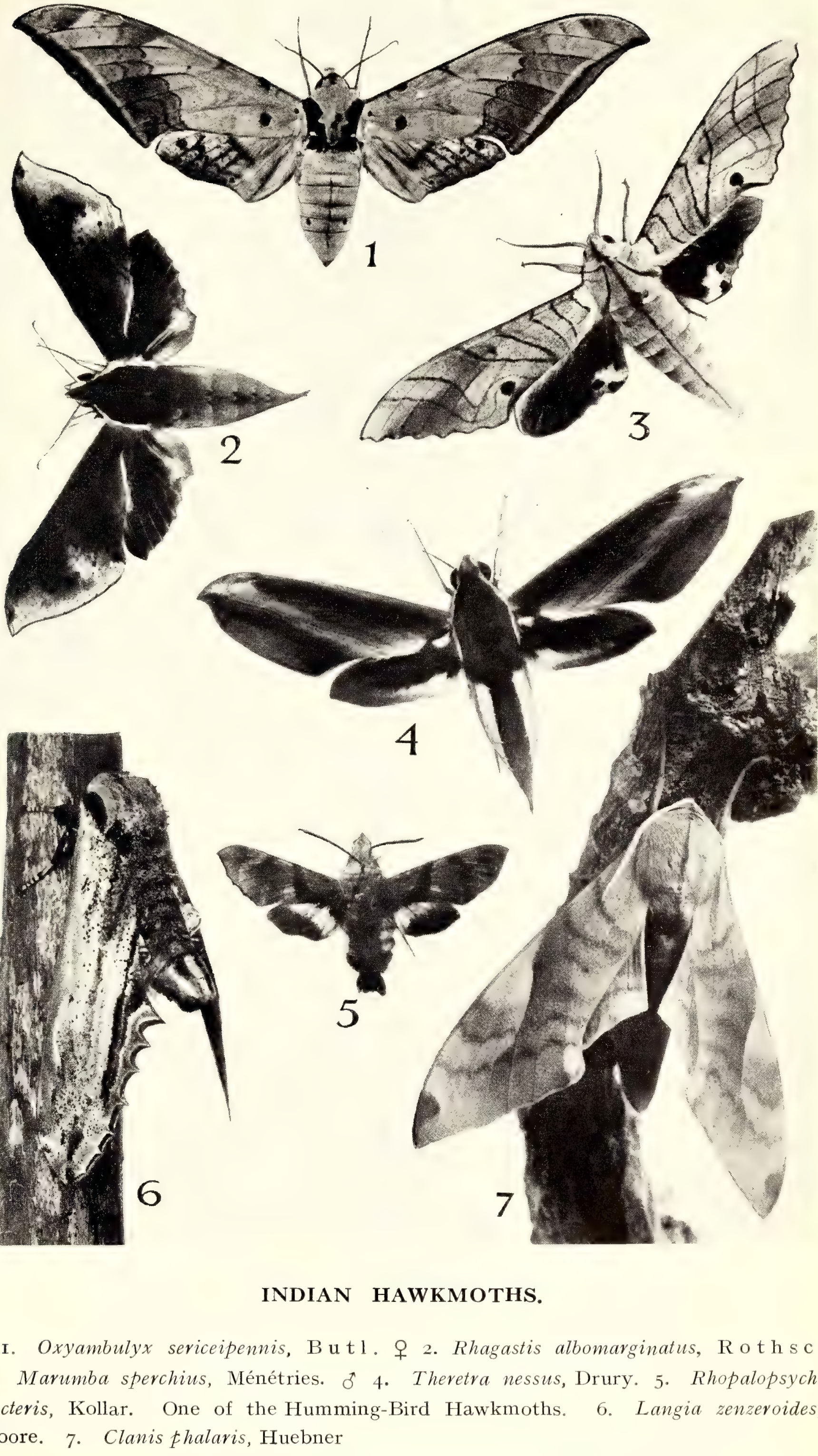
(*With 3 plates and 9 text-figures.*)

The Hawkmoths belong to the Natural Order *Lepidoptera*, or scale-winged insects. This Order is divided into the Butterflies (*Rhopalocera*), which have the antennæ ending in a club, and the moths (*Heterocera*), which have the antennæ of various forms other than clubbed at the ends. The moths are divided into Groups, and the Groups into Families, the Hawkmoths or *Sphingidæ* being one of the Families. The scientific name is derived from 'sphinx', the designation used by Réaumur for the English Privet Hawkmoth, on account of the fancied Sphinx-like attitude adopted by the caterpillar when it is alarmed, and the name was later adopted by Linnæus for the whole Family.

DISTRIBUTION AND FOOD-PLANTS.

There are but 17 species of Hawkmoths known to occur in the British Isles, and some of them are only rare visitors. In the Indian Empire about 180 species are known to occur, out of a total of about 850 species known throughout the world. Some of the Indian species are very common, others so rare that only one or two individuals have so far been obtained. Some of the species are widely spread, others very local in their occurrence. A few of the species which are found in England are found also in India. These are the Convolvulus, Broad-bordered Bee, Oleander, Humming-bird, Spurge, Bedstraw, Striped and Silver-striped Hawkmoths. Two species of Death's-head Hawkmoths are found in India, but they are not the same as the English species. These are the only species which have been given 'common' names. The rest are known only by their scientific names.

Certain parts of India are more rich in species than other parts. Areas with a heavy rainfall and a large variety of trees and plants produce the largest number, and dry areas with poor vegetation the smallest number, though individuals of certain species may occur in vast numbers in both wet and dry areas, becoming serious pests on crops and other plants. Probably many new species remain to be discovered, but of those now known 58 species occur in the west Himalaya (west of Nepal), 128 species in the east Himalaya (east of Nepal, and including Assam), 73 species in the South of India and 40 in Burma. Many more species must occur in Burma, but very little collecting has been done there. The North Kanara district of Southern India is very rich, having over 45 species in an area of



INDIAN HAWKMOTHS.

1. *Oxyambulyx sericeipennis*, Butl. ♀ 2. *Rhagastis albomarginatus*, Rothsc. 3. *Marumba sperchius*, Ménétries. ♂ 4. *Theretra nessus*, Drury. 5. *Rhopalopsyche nycteris*, Kollar. One of the Humming-Bird Hawkmoths. 6. *Langia zenzeroides*, Moore. 7. *Clanis phalaris*, Huebner

3,600 sq. miles. The distribution of the species overlaps, some of them occurring in more than one of the areas mentioned. The plains area of Northern India has no special Hawkmoth fauna of its own, but receives contributions from the surrounding areas. The information on this subject is very scanty and it is worth recording the locality where any Hawkmoth is obtained.

The distribution of the moths is dependent to a great extent on that of the food-plants on which the caterpillars feed, though the moths are such fast fliers that they may be found a long way away from the nearest food-plant. Some species feed on a wide range of food-plants, others confine themselves to one or more. The food-plant on which any Hawkmoth caterpillar is found feeding should also be recorded. Plants belonging to the botanical Order *Rubiaceæ*, to which *Randia*, *Gardenia*, Madder, Bedstraw and other shrubs, herbs and creepers belong, is the most popular food-plant, about 30 species feeding on plants of this Order. Vines (Grape vine, Virginia creeper, *Leea*) and Arums (Garden arum, Caladium, Cuckoo-pint, Snake plant) are the next most popular, with about 16 species each. Leguminous trees and plants (Indian Beech, Shisham, Indian Laburnum, Shiras, Gram, Pulse) come next, followed by Balsams and Spurge. Altogether about 50 Orders of plants are represented in the list of Hawkmoth food-plants known up to the present, ranging from the largest trees to the most insignificant herbs, and including even grasses.

THE HAWKMOTH.

I have often heard the questions asked 'What is a Hawkmoth ? How can one tell a Hawkmoth from any other kind of moth ?'

In order to do so with certainty, it is necessary to make a minute examination of the veins of the wings and of the organs of the body, but for all practical purposes something more simple will suffice. Hawkmoths can usually be recognised by their characteristic appearance and habits. The fore-wing is long, narrow and sharply pointed ; the hind-wing short and rounded ; the eyes large ; the chest or *thorax* heavy ; the body or abdomen shaped like a cigar, or like the pointed end of a cigar. This last character is sometimes obscured by lateral tufts of hairs giving the impression of a broad tail, such as occurs in the Humming-bird Hawkmoths and a few other genera (Plate I, fig. 5) ; but the other characters are present, and also the clean-cut, high-bred appearance common to all Hawkmoths (Plate I). Finally, if when strolling in your garden in the evening you notice a moth, poised almost motionless except for its rapidly vibrating wings in front of a flower, suddenly darting away and as suddenly re-appearing, and never settling, you may be sure you are observing a Hawkmoth, since no other kind of moth is known to feed in this manner. If you look more closely you will see that when poised before the flower, the moth unrolls a long tongue or proboscis, and probes the flower for honey. All Hawkmoths which have been seen feeding, with the single exception of the Death's-head Hawkmoths, have this habit of feeding when on the wing. The Death's-head moths are known to enter bee-hives to steal the honey. The vibration of the wings makes a deep humming note when the moth is flying, and some species produce a similar note when at rest, if they are disturbed.

The Hawkmoth caterpillar can be recognised by the hard, chitinous horn on segment 12, though a few caterpillars of other families have a somewhat similar, but soft fleshy horn.

THE EGG.

The eggs of Hawkmoths are round or oval, and are most commonly of a green colour with a translucent appearance, like a tiny, green grape, but they may be almost white or pale yellow, or more rarely brown or orange, in different species. The egg-shell is either smooth and shiny, or dull, and no sculpturing is visible to the naked eye. The eggs of different species vary a good deal in size, the smallest being about 1 mm. in length, and the largest about 3 mm. The average size is about that of a pin's head.

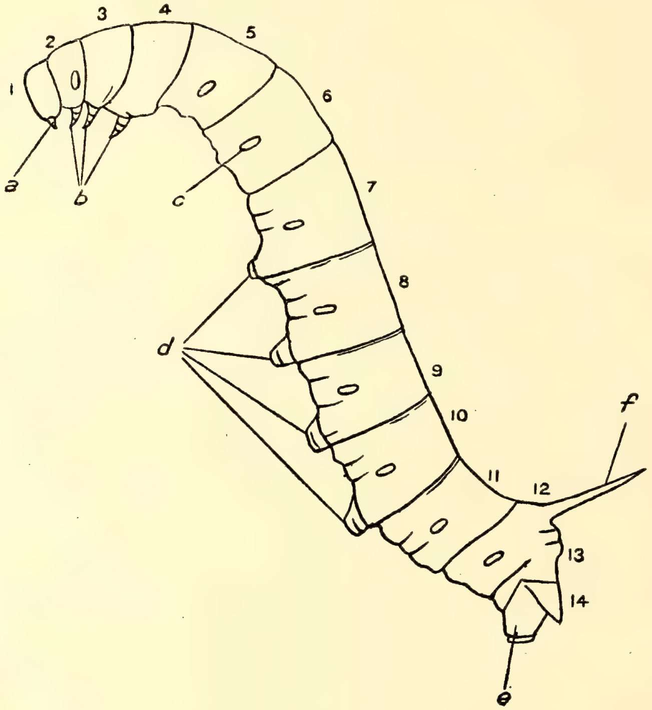
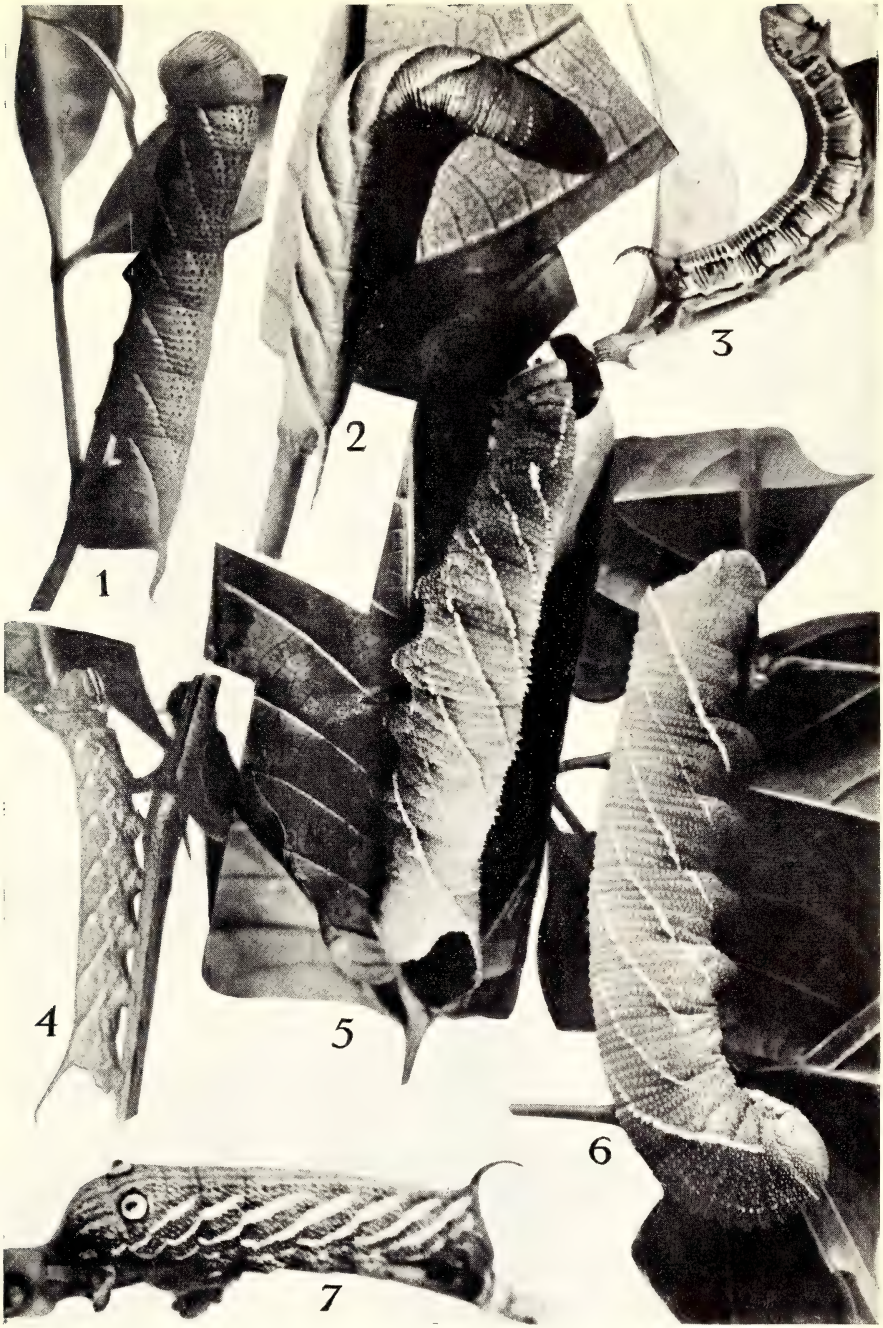


Fig. 1. A Hawkmoth caterpillar, showing segments. 1 (the head) to 14 (the anal segment).

a, the antenna; *b*, the true legs; *c*, a spiracle, or breathing hole; *d*, the prolegs; *e*, the anal clasper; *f*, the horn.

THE CATERPILLAR OR LARVA (FIG. 1).

The Hawkmoth caterpillar, like other insects, has a head and thirteen other segments. There are different ways of numbering these segments, but we have adopted the method shown in figure 1,



INDIAN HAWKMOTHS.

1. *Acherontia styx,* Westw. One of the Death's-Head Hawkmoths. Note the twice curved horn and oblique stripes. 2. *Psilogramma menephron,* Cramer. Note the wart-like tubercles and oblique stripes. 3. *Cephonodes hylas,* Linn.; in Sphinx-like attitude. Note the tubercles on segment 2 and horn, and the spiracles. 4. *Pseudodolbina fo,* Wlk. Note the wart-like tubercles and oblique stripes. 5. *Marumba sperchius,* Ménétries. Note the tubercles all over, and the oblique stripes. 6. *Clanis phalaris,* Huebner. Note the very small horn, tubercles and oblique stripes. 7. *Rhagastis albomarginatus,* Rothc. Note the conical ocelli, and oblique stripes.

counting the head as segment 1, the segment next to the head as segment 2, and so on. The body of the caterpillar is usually round in section, and is more or less cylindrical in some species (Pl. II, figs. 1 to 6), and in other species increases rapidly in diameter from the head to segment 5, and then becomes cylindrical to segment 12 (Pl. II, fig. 7 ; Pl. III, figs. 1, 2). Segment 2, 3 and 4 each bear a pair of *true legs.* These are hard and shiny, have three joints and a claw for gripping at the tip (fig. 1. b). They are called 'true legs' as they occur on the same segments as they do in the moth. Segments 5 and 6 are without legs. Segments 7 to 10 each have a pair of *pro-legs* or false legs (fig. 1 d). These legs are not present at all in the moth. They are fleshy and soft, with a circular pad set all round with curved hooklets, which enable the caterpillar to obtain a firm grip on any surface. Segments 11 to 13 are again without legs, but segment 14 bears the *anal claspers* (fig, 1 e). The anal claspers are similar to the pro-legs but have a still larger gripping surface. So tightly does the caterpillar cling to any rough surface that if it is pulled away, the ends of the pro-legs and claspers are sometimes torn off. Segments 2 and 5 to 12 each have a pair of *spiracles* or breathing holes (fig. 1 c). These, with the air-tubes or *tracheae* which start from them and spread through the tissues of the body, supplying them with oxygen, take the place of the breathing apparatus in mammals, birds and reptiles. The spiracles are oval in shape and have a central slit or opening down the long axis. They are of different colours in different species. Those on segments 2 and 5 to 11 are placed vertically in about the middle of the segments, and that on segment 12 obliquely. Segment 12 bears the horn which is so characteristic of Hawkmoth caterpillars (fig. 1 f). Segment 13 is narrow and rather difficult to make out sometimes, as it is wedged between segments 12 and 14. Just above the anal claspers on segment 14 is the *anal flap*, a fleshy triangular flap which covers the anus. The head (fig. 2) is made up of separate chitinous plates fused together into one piece. The front part of the head is called the *face.* This is made up of a triangular plate called the *clypeus* (fig. 2, a) and the frontal portion of the two lobes (fig. 2, b). The sides of the head are called the *cheeks.* Projecting from the lower part of each cheek are the *antennæ* (fig. 1, a and fig. 2, c). These have three joints, and two bristles, a long and a short one, at the tips of the end joint. The bases fit into sockets in the cheek, and the whole organ is moveable. The function of the antennæ is not known with certainty. Between the antennæ are the powerful jaws or *mandibles* (fig. 2, d) with their bases also set in sockets in the cheeks. They are wedge-shaped, curved near the tips, with bevilled edges working

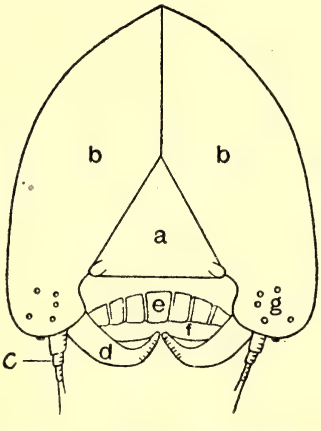


Fig. 2. Head of a Hawkmoth Caterpillar.

against each other sideways, and are used to cut pieces from the leaf when feeding. Behind the mandibles are mouth-parts called the *labrum* (fig. 2 e) and the *ligula* (fig. 2 f) which come into play when the catterpillar is feeding. Above the base of each antenna is a group of five eyes directed forwards, and a sixth eye is near the base of the antenna but directed downwards (fig. 2 g). These are very small, hardly visible to the naked eye, but under a magnifying glass appear as circular, convex, black dots. It is doubtful if the caterpilliar can see more than a few inches with these eyes. Behind and below the mandibles is a small cone with a perforated tip, which is the *spinneret* from which a thread of silk can be spun at will.

Pupa or Chrysalis (fig. 3, 4 and 5).

The Hawkmoth pupa has a shell or casing of hard chitinous material, inside which the moth forms. The pupa has the same number of segments as the caterpillar. The head (segment 1), the thorax (segments 2 to 4) and segments 5 to 8 of the abdomen are all fused together so that they are immoveable, but the remaining segments of the abdomen are jointed and moveable (fig. 3). The

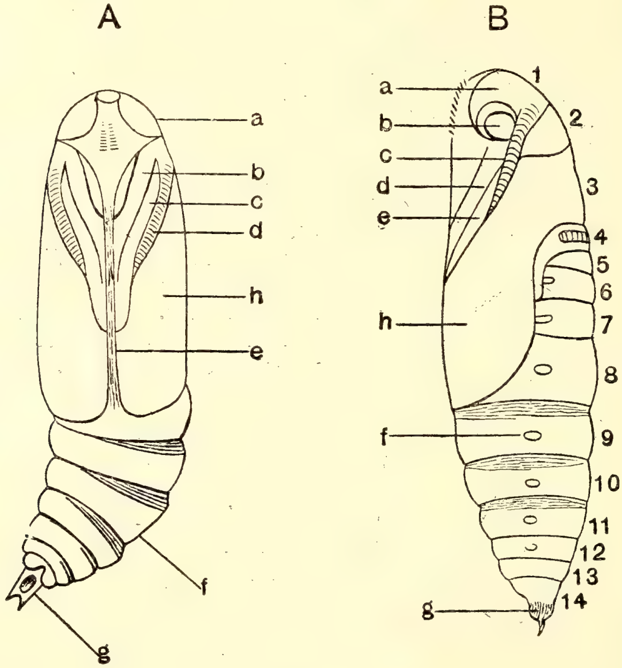


Fig. 3. Pupa or Chrysalis of a Hawkmoth.

A. Ventral view ; *a*, the head ; *b*, foreleg ; *c*, midleg ; *d*, antenna ; *e*, tongue ; *f*, a spiracle ; *g*, cremaster ; *h*, wings.
B. Lateral view.—*a*, head ; *b*, eye ; *c*, antenna ; *d*, foreleg ; *e*, midleg ; *f*, spiracle ; *g*, cremaster ; *h*, wings.

head is usually round and blunt, the abdomen pointed as in the moth, the body being thickest in the middle. The case is so moulded that the position of the head, eye, tongue, fore and middle legs, the antennae, folded-up wings and the body of the future moth can be seen (fig. 3). The tongue runs down the middle of the ventral surface, and may or may not reach the end of the wing-cases. On either side of it are the lower part of the fore legs, then the middle legs and then the antennæ. The hind legs are concealed under the edge of the wing-cases, which start near the antennæ and reach about half way down the ventral surface of the pupa. At the end of segment 14 is the *cremaster* (fig. 3, g). This is an organ of hard chitinous substance, which is either triangular or spike-shaped, and usually branches into two points. These points may again divide into two, and there may be one or more pairs of small hooks. The shape of the cremaster and the arrangement of the hooklets provide a valuable means of identifying different species in the pupal stage. The cremaster does not appear to perform any function except when provided with hooklets. When these are present they are used to fix the tip of the abdomen to a pad of silk woven by the caterpillar at the end of the cocoon. Spiracles are present on segments 2 and 5 to 12 as in the caterpillar, though that on segment 5 is concealed by the edge of the wing-case.

In some species of Hawkmoth the tongue is very long, and it cannot be accommodated in a pupal case shaped as in figure 3. It is then housed (to use a mechanical term) in a special hollow casing which projects in front of the head of the pupa (fig. 4). The Convolvulus Hawkmoth (and a few other species) has such an excessively long tongue that it cannot be accommodated even in this manner, and it is then housed in a *free tongue-case* (fig. 5). The tongue starts from the front of the head, runs along the case to its bulbous end where it turns back on itself and re-joins the head casing, then

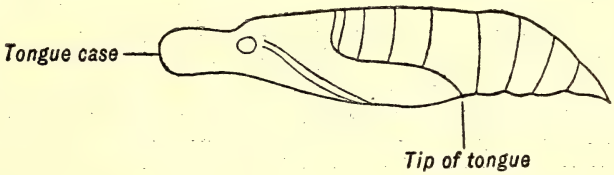


Fig. 4. Chrysalis of Hawkmoth with tongue case.

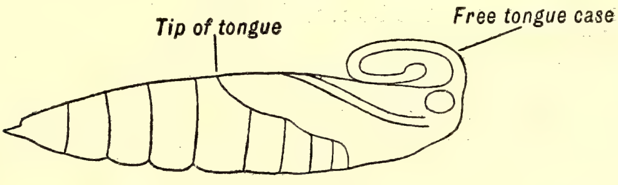


Fig. 5. Chrysalis of Hawkmoth with free tongue case.

runs between the wing-cases to the end of the latter. This free tongue-case looks like the handle of a jug.

In colour the pupa is chestnut or dark-brown in the case of those species which pupate underground, and of various colours, with dark or pale dots, stripes or patches in the case of those which pupate on the surface. The surface of the pupal case may be smooth and shiny, or dull, and is sometimes shagreened or covered with small tubercles, and sculpturing is sometimes present on segment 4 or near the spiracles and head.

MOTH OR IMAGO

The general appearance of the Hawkmoth has been already described. Those who wish to study the structure are referred to Rothschild and Jordon's great work on the Hawkmoths, *The Revision of the Sphingidæ*, in *Novitate's Zoologicæ* Vol. IX, Supplement (1903).

LIFE HISTORY AND HABITS

The Hawkmoths, with very few exceptions, lay their eggs singly, usually on the undersides of the leaves of the food-plant or plants on which their caterpillars feed. Each egg is stuck firmly to the leaf or twig with some sort of gum secreted by the moth. The operation of egg laying has not been observed in natural conditions in the vast majority of Hawkmoths, as it is usually carried out after dark, but a few day-flying species have been seen laying their eggs, and they have done it on the wing, without settling. While poised delicately over a leaf or a young shoot, the tip of the abdomen is turned up or down and an egg quickly deposited. The moth then darts away to repeat the operation elsewhere. When a large number of females of any species are engaged in egg laying, several eggs may be found on a single leaf or plant but they are almost certainly laid singly at different times by the same or different females. Most butterflies, and a few moths also lay their eggs singly, but the eggs of butterflies can usually be distinguished from those of Hawkmoths by being of various shapes, and by the shells being sculptured into patterns visible to the naked eye. The eggs of some of the swallow-tail butterflies are very similar to Hawkmoth eggs, and one might be taken in by the resemblance until the young caterpillars hatch out. All doubt is then dispelled by the presence or absence of the horn which is the distinguishing mark of the Hawkmoth.

The egg usually becomes paler in colour a few days after being laid, owing to the transparent shell allowing the colour of the caterpillar which is forming inside to be seen. If the egg is examined under a fairly strong magnifying glass just before the young caterpillar is due to emerge, the head and some parts of the body may be made out.

The young caterpillar or *egg-caterpillar* comes out in 5 to 10 days after the egg is laid, the larger species usually taking a longer time to hatch than the smaller species. The egg-caterpillar eats a hole in the side of the egg-shell, and makes its way out in a minute or so. Most commonly it is of a pale yellow colour, including the horn, but the horn soon becomes black. The body is covered with hairs which are visible to the naked eye in some species. The caterpillar eats more or less of the egg-shell for its first meal and after resting for a time along the midrib or a vein of the leaf, starts to eat the leaf itself. It often eats small holes in the middle of the leaf at first, and tackles it from the edge when it grows a bit bigger. After feeding for a few days the body becomes too big, not for its boots, but for its head and legs, which are unable to stretch like the skin of the body does. The caterpillar then settles down to change its skin and acquire a larger head. It lies motionless along a midrib or vein for some hours, and then the new larger head may be seen forming under the skin behind the old head. The old head is pushed forward till the skin breaks round the neck. Then by an undulating movement of the body the old skin is worked back, until, with a waggle of the claspers it is cast off, and the old head is also got rid of. Some species eat the cast-off skin. After resting for a time the caterpillar starts feeding again, and when the body becomes too large for the head it changes its skin again. In most species there are four such changes of skin before the caterpillar reaches the final or mature stage (each stage being called an *instar*), and there is some change of colouring or form or both at each moult. The ocelli or other markings gradually develop, and the shape of the body and of the horn may differ in each successive moult. The caterpillar feeds more and more voraciously as it nears maturity, then suddenly stops feeding and remains motionless for about 24 hours. During this period of rest it often becomes of a darker colour in preparation for its descent to the earth, green caterpillars assuming a pink or brown suffusion along the back, and dark-coloured caterpillars becoming still darker.

Suddenly leaving the food-plant the caterpillar begins to look for a suitable place to pupate. Those species which pupate underground get very agitated and hurry along the ground with a quick undulating motion, and if touched, lash their bodies wildly from side to side. Their pro-legs and claspers gradually lose their power of gripping, and the caterpillar falls over lumps of earth and other obstructions in its anxiety to get safely underground. When it finds a soft place, it immediately starts digging with its head, and very soon disappears under the surface. It may dig down to a depth of 6 or 8 inches, and there makes a large oval cell in which it turns to a pupa.

The species which pupate on the surface (these are the larger number) do not have to travel so far to find a suitable spot, and are more leisurely in their movements. They crawl under dead leaves and vegetation, and make a rough cocoon by joining leaves, earth and rubbish together with a few strands of silk from the spinneret.

The change to a pupa takes place from two to ten days after going underground or starting the cocoon, but in one or two species, may not take place for several months. The change to the pupa is not carried out in the same way as the moults in the caterpillar. When ready to pupate, the head of the caterpillar splits down the front, and the head of the pupa is pushed through the slit. The skin of the caterpillar, with the head attached to it in two halves, is then worked back over the body of the pupa. The pupa is at first soft and shapeless, and the sheaths or cases which will later on contain the antennæ, legs, wings and tongue are separate from the body, but they soon fall into their final positions and become firmly fused to the body. The pupal case hardens and assumes its final form and colouring. After lying nearly motionless for a period of from a fortnight to several months, according to the species and the time of year and other factors, the pupal shell splits open along the dorsal line of the thorax, the head and tongue case breaking away together, and the moth emerges and dries its wings, and darts away to feed and find a mate. After mating, the male dies, the female lays her eggs to start a fresh brood and then she also dies.

This is a short outline of the life history of the Hawkmoth. There are many variations, some common to whole subfamilies or genera, others peculiar to certain species, but it is not possible to give more than a general account in these notes.

COLOUR AND MARKINGS.

When first hatched, the Hawkmoth caterpillar is usually some shade of pale yellow or yellow-green, and is without markings. In a few cases only the colour is brown or black. After feeding for a time the green colour of the food sometimes shows through the body, giving it a green tinge. In the second and third instars, that is, after the first and second changes of skin, the colour is usually green, and the oblique stripes and other markings begin to appear. Where the mature caterpillar has the eye-like markings called *ocelli*, these first show as round spots of a uniform colour, and develop with each change of skin till they reach their final form. In the greater number of species the colour remains green in the fourth and fifth instars (the fifth usually being the final instar before the caterpillar pupates), but there is in some cases a startling change in the fifth instar, the ground colour of the head and body changing from green to brown, black or purple. The oblique stripes and other markings may remain unchanged or may be greatly modified. Even in the case of those species in which the colour is normally green till maturity, individual caterpillars may assume this dark form of colouring in the final or in earlier instars, and in a few species there are three or more differently coloured forms. The various forms are so unlike each other in colour and sometimes in markings as well, that one would not believe them to be the same species, but the moths bred from the different forms are identical. There are other cases where the change to a dark form is not complete, certain individuals developing dark patches which do not cover the whole body. In the few cases where the egg-caterpillar is black, the colouring may remain black (or dark) throughout, or there may be both dark and green forms. The different cases may be summarised as follows, in the order of their occurrence in nature :—

(*a*) The caterpillar is always green in the earlier instars, later has both a green and a dark form, or three or more different forms.

(*b*) The caterpillar is always green from birth to maturity.

(*c*) The caterpillar is always green in the earlier instars, later has a green form with or without dark patches.

(*d*) The caterpillar is always green until the last instar, always dark in the last instar.

(*e*) The caterpillar is dark in the earlier instars and later has only a dark form, or both dark and green forms.

The occurrence of two or more differently coloured forms in the caterpillar, with no corresponding change in the moth, is very curious. It cannot be accounted for by any difference in food, since the different forms are found feeding on the same plants. The green form is usually the most common in nature, or at least the form most commonly found, but when specimens are bred from an early stage in a dark tin or box, a far larger proportion of them assume the dark form. This seems to show that absence of light is a factor in influencing the colouration. On the other hand, dark-coloured specimens are found in nature in the same situations as the green forms, both forms being exposed to the same amount of light. Also, where there is only a dark form at maturity, the dark, mature caterpillars are often found during day-light in the same situations as green forms of other species. I had a curious experience with caterpillars of the Convolvulus Hawkmoth at Sheikh Othman, near Aden. There were large numbers of them in the earlier green stages on a certain creeper, but no mature caterpillars could be found. Someone suggested keeping the small caterpillars in more or less natural conditions in a large box. On doing so it was found that all specimens turned to a dark form at maturity, and that during the day they left the food-plant and hid among dead leaves and even buried themselves in the earth to avoid the light. This experience does not lead us to any conclusion, since it may be argued either way—that the caterpillars hid themselves because they had assumed the dark form, or that they assumed the dark form because they had developed the habit of hiding during the day. Further evidence on this question is required to enable the problem to be solved.

In addition to the general colouring, Hawkmoth caterpillars have various markings, the most common style of markings being longitudinal stripes, oblique stripes and ocelli. Longitudinal stripes may be present in combination with either oblique stripes or ocelli, or all three types of markings may appear together. The longitudinal stripes may be present along the back (*dorsal*), high up on the side (*dorso-lateral*), through the spiracles (*spiracular*) or below the spiracles (*sub-spiracular*). The oblique stripes are usually seven in number, on segments 5 to 11 : that on 11 extending upwards and backwards over segment 12 to the base of the horn. (Pl. II). The ocelli occur in one pair on segment 5, or two pairs on segments 5 and 6 or in seven pairs on segments 5 to 11. In one species there is an extra pair on segment 4. The ocelli are round or oval, and usually have a dark centre surrounded by a paler colour and then a dark ring (Pl. III, Figs. 1, 3, 5, 6). In some cases they are convex in section and shiny in appearance, and then the resemblance to a real eye is increased (Pl. II, Fig. 7). The ocelli usually lie on the dorso-lateral line, but in a few cases the spiracle on segment 5 is ringed with colour, so that it resembles an ocellus.

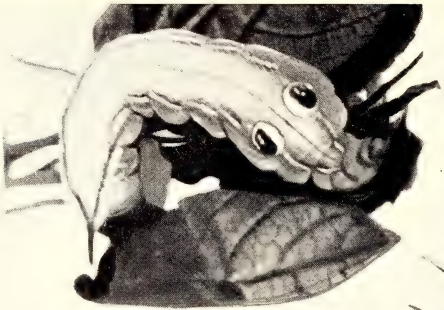
At each change of skin, the shape of the head, body and horn may change, as well as the colouring. In the egg-caterpillar the head is always round, and it may remain round to maturity, or it may become triangular or pointed in the second instar (Pl. III, Fig. 4). In a few cases the head of the egg-caterpillar is round, it then becomes triangular or pointed, and at maturity again becomes round. The body is nearly cylindrical at birth, and remains so to maturity in some species, while in other species the fourth and fifth segments become tumid or swollen. The horn of the egg-caterpillar is always straight, slightly tapering, and *bifid*, or with two points, and each point bears a hair or *seta*. The double point is usually lost in the later instars, but in some cases persists to maturity. The horn may remain straight, or it may become curved downwards, more rarely upwards, and in a few cases it is twice curved, first down and then up, as in the Death's-head Hawkmoths. The shape, thickness and relative length varies greatly in different species, and in some of the genus *Clanis* may be so small as to be overlooked (Plate II, Fig. 6).

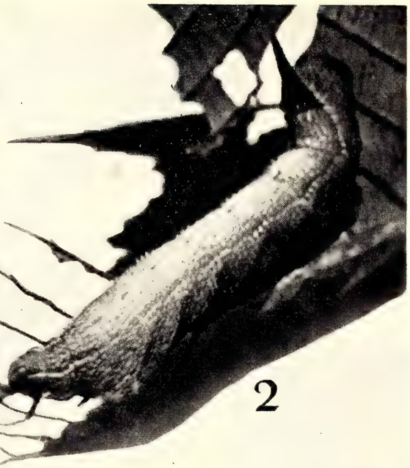
In the egg-caterpillar the horn can be moved at will in a vertical plane and this limited power of movement is retained in a few species, where the horn is very thin up to maturity, but in most species all power of movement is lost in the later instars, and the function of the horn, if any, is unknown. In some Hawkmoth caterpillars from South America the horn is very long and whip-like and can be moved freely over the back of the caterpillar like the filaments of the Puss-moth caterpillar. In these species it may serve to drive away parasites, but it is not long or mobile enough to be of any use for his purpose in any Indian species.

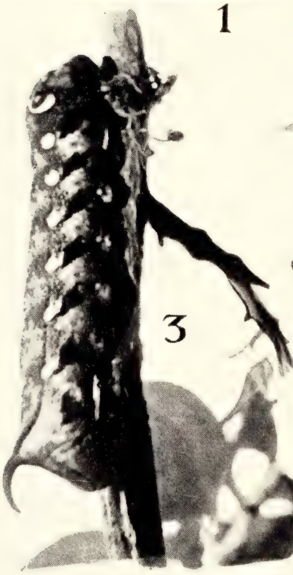
The surface of the head, body and horn is usually dull, and either smooth or tuberculate. The tubercles may cover the whole surface, or may be present on certain parts only. Sometimes only the horn is tuberculate, or the tubercles may run along the back or along the line of the oblique stripes. In one species they have developed into long fleshy spines, and in others into wart-like prominences. Hairs are always present, but except for a few on the head, legs, pro-legs and anal flap, are too small to be seen without a lens. (Plates II and III).

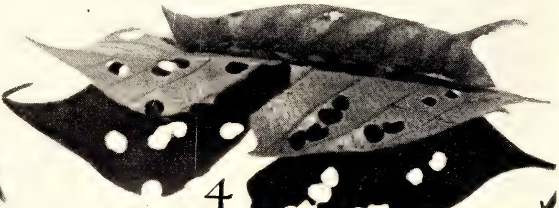
MEANS OF DEFENCE AND ENEMIES.

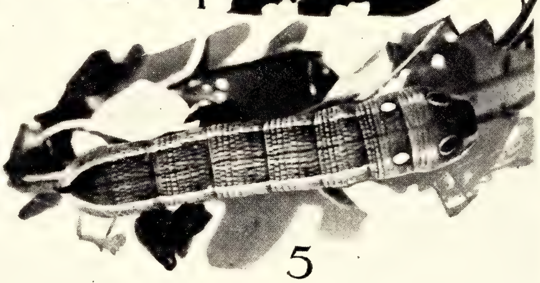
The Hawkmoth caterpillar is a most defenceless creature. Having no long hairs or poisonous spines such as many other kinds of caterpillars have, it falls an easy victim to many other creatures. Its only hope of escaping from its enemies is to avoid detection, and for this purpose its habits and colouring are admirably adapted. It habitually lives on the underside of the leaves of the food-plant, and grasps the midrib or a vein with its pro-legs or claspers, its head directed towards the point of the leaf. When resting it is entirely hidden from above by the leaf, and when feeding only the head and

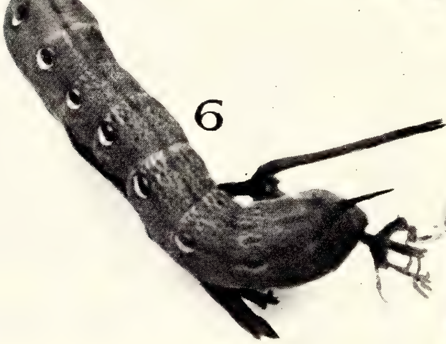


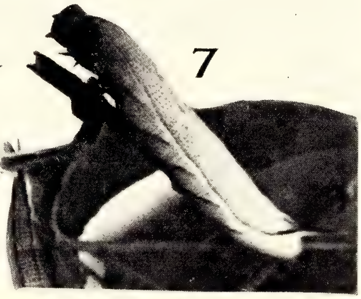








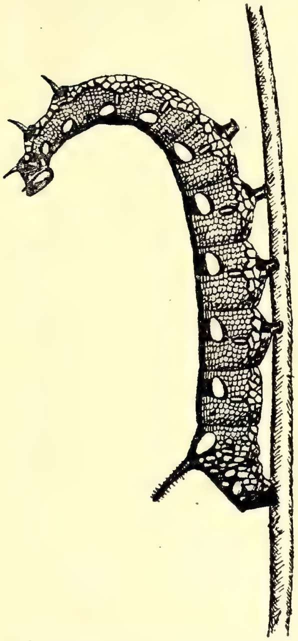




INDIAN HAWKMOTHS.

1. *Rhagastis confusa,* Rothsc. Note the large ocelli. 2. *Ampelophaga khasiana,* Rothsc. Note the tubercles and the dorso-lateral stripes. 3. *Theretra clotho,* Drury.; dark form. Note the seven pairs of ocelli. 4. *Degmaptera mirabilis,* Rothsc. Note the pointed head and pointed horn. 5. *Hippotion celerio,* Linn. Note the two pairs of ocelli, dorsal and dorso-lateral stripes. 6. *Theretra alecto,* Linn. Note the seven pairs of ocelli 7. *Macroglossum pyrrhosticta,* Butl. A Humming-Bird Moth.

one or more pairs of legs are visible. When young, the pale colouring matches that of the midrib, and later, when the green colour and the oblique side stripes have developed, the latter lie parallel to the side veins, and the whole creature appears to melt into the leaf. Some species have irregular spots which look like dead patches in the leaf. When once discovered and attacked, the caterpillar can only defend itself by raising the front part of the body and hitting sideways with the head. The Death's-head caterpillars increase the effect by making a clicking noise with their jaws, and those of *Langia zenzeroides* and other species make a loud squeak at each stroke by expelling air forcibly through the spiracles. Those caterpillars which have ocelli draw in the head and anterior segments into segments 4 and 5, at the same time puffing out these two segments as to expand the ocelli to their full extent (Pl. III, Fig. 1). This gives them a somewhat snake-like appearance, and the effect is enhanced by their raising the fore-part of the body and waving it from side to side. The Spurge Hawkmoth caterpillars have a more effective means of defence. They live gregariously on the Spurge, a dozen or more perhaps on a plant. When disturbed, they throw back the head and fore-part of the body and eject drops of clear green fluid (fig. 6). The effect of their simultaneous action is most startling, and probably serves to drive away small enemies. Their striking appearance, lack of concealment and the poisonous nature of their food-plant point to their being unpalatable to birds.



FIG, 6. Spurge Hawkmoth Caterpillar's attitude in defence.

The enemies of the Hawkmoth caterpillar are many and varied. The wolf-spiders jump on them when they are small, and suck their juices. Ants of most kinds consider them fair game and attack them regardless of size. It is reasonable to assume that birds and lizards eat them when they can find them, and that hunting wasps carry them off to their burrows or cells, though I have never actually seen them doing so. Judging from the gusto with which some Slender Loris I once kept devoured the huge caterpillars of *Clanis phalaris*, such insectivorous mammals must take their toll. They would seize the caterpillar in both hands, and having first scrunched up the head would work steadily down the still squirming body, the green juices dribbling down them the while—a horrid proceeding. But the really insiduous foes, which probably cause more destruction than all the rest put together, are the parasitic wasps and flies. One minute species of wasp lays its eggs in or on the eggs of the Hawkmoths, probably when the latter are freshly laid and still soft. Small grubs hatch out and eat the substance of the egg. The eggs which have been attacked turn first grey, and then mottled with black and white, the white patches being the pupæ of the wasp. If kept under observation a tiny wasp will be seen to come out of a small round hole which it has bitten through the shell of the egg, and the rest of the brood will scramble out after the first at short intervals.

The caterpillars themselves are attacked by several kinds of parasitic wasps and flies, from the time they are about half-grown to maturity. The method of attack is the same as in the case of the egg, but the parasites are much larger. The grubs feed on the tissues of the living caterpillar, which carries on as usual till one day it is seen to be covered with small cocoons like ants ' eggs ', which stick out all over its body like almonds in a pudding. The maggots, being full fed, have made their way out through the skin of the caterpillar and formed their cocoons there. If brushed off, each cocoon leaves a black spot on the skin, and the caterpillar presently dies. Other species of maggots carry on their fell work unseen till the caterpillar is found, still holding on by its claspers and one or more pairs of pro-legs, but the upper part of its body hanging down limp and empty except for the squirming maggots. These when full fed form hard cocoons inside the empty skin, from which the perfect insects emerge in due course. Sometimes the caterpillar succeeds in pupating. The maggots continue their horrid feast, and form their cocoons inside the pupal shell. Then, instead of the beautiful moth we had expected, half a dozen nasty-looking flies or a wasp or two come out. Some species seem to be far more often attacked by parasites than others, and to suffer more in some years than in others.

It is not known what enemies the pupæ have in nature, since they are so seldom found, but when kept in artificial conditions they are attacked by the small black fly mentioned under ' breeding '.

The moths are so swift on the wing, and hide so skilfully when resting, that they probably have few enemies, but bats certainly catch them. A friend once told me that he used to find the wings of Hawkmoths in his verandah every morning, under a hook where a bat used to hang while it devoured their bodies. All observations on the subject of enemies and means of defence would be of interest.

Breeding and collecting.

The breeding of Hawkmoths, though a somewhat exacting hobby if undertaken on a large scale, is very fascinating and of great scientific value, as so little is known about the early stages and habits. It is the only method by which perfect specimens of the moths can be obtained, and many of the more rare species cannot be obtained at all in any other way, except by chance.

' First catch your hare.' Choose some likely-looking spot where there is plenty of vegetation, and search systematically by turning over leaves and branches and pulling up strands of creepers, so that the undersides of the leaves are exposed. Keep a sharp lookout for leaves which have been eaten, and along roads, paths, stream-beds and similar places look on the ground for droppings, or *frass*, which give away the presence of caterpillars feeding somewhere above. At first one will not have much success, but the eye soon learns to glance from leaf to leaf and to pick out an egg or caterpillar. The caterpillars found will not always be those of Hawkmoths, and beetles also feed on leaves ; but beetles are ragged and untidy feeders. In the hills and other places where it gets cold in the winter, eggs and caterpillars will be found from about April to November, but where it does not get cold, may be found at any time.

It is best not to touch the eggs or caterpillars, but to pick the leaves or twigs on which they are found, and put them in a tin with small holes punched in the lid or in a wooded box. Eggs take about a week to ten days to hatch, and the young caterpillars should be supplied at once with fresh leaves of the plant on which they were discovered. After eating more or less of the egg-shell they may start feeding on the leaf, or they may wander about aimlessly without feeding. If they will not start feeding it is either because they have not been given the proper food-plant, or else, especially in a dry climate, that they require water. Sprinkle a few small drops of water on the leaves. When the caterpillar comes across a drop it will cock up its tail once or twice, and then suck it up and look for more. Don't overdo the water. The little beast may drown itself in a large drop or the leaves may become affected with mildew if the air is damp, and kill it. Fresh leaves should be given every day, and the tin or box kept clean. The best way of doing this is to turn out the contents on to a sheet of paper, and clean out the frass or droppings ; put fresh leaves in and sprinkle them with water ; snip off the bits of leaf on which there are unhatched eggs or young caterpillars, and put them back in the tin, throwing away the rest. As the caterpillars grow transfer them to larger tins or to wooden boxes. Keep them supplied with fresh leaves and turn out the old leaves and droppings daily, otherwise mildew will start and kill the caterpillars. Any caterpillars which die should be removed for the same reason. The food-plant can be kept fresh by putting it in water but care must be taken to prevent the caterpillars from drowning themselves by stuffing leaves or moss into the mouth of the bottle or vase, round the stems of the plant. Another method is to park out caterpillars on a bush or a bough of the food-plant, covering them with a bag of muslin or fine cloth. A rag soaked in kerosine must be wrapped round the stem or bough to prevent ants from getting at the caterpillars.

In spite of all precautions, caterpillars often die from having been attacked by parasites before they were found. The changes of skin, or moults, are also the cause of many casualties, especially when the caterpillars have not been given enough moisture. Changing skin is a tricky operation, and things may go wrong. Sometimes the old head remains fixed over the mouth-parts of the newly-formed head, and the caterpillar cannot feed. Sometimes the skin gets so dry that it will not split properly, and unbroken strands constrict the swelling body. A little assistance, if given in time, may save the caterpillar. I have often operated successfully with a paint brush dipped in water, and fine forceps or a pin !

As the caterpillar nears maturity it feeds more and more greedily, till suddenly, being full fed, it stops eating and rests motionless for a day or so. It is about to pupate, and it is time to prepare a place where it may do so comfortably. Some Hawkmoth caterpillars pupate underground, but the larger number do so on the surface. For the former it is best to have a wooden box with 4 or 5 inches of soft earth, and for the latter a box half full of dry leaves or torn-up newspaper. If in doubt, put the leaves or paper on top of the earth. Those that wish to go underground will do so, and the others will make their cocoons on the surface. Leave them undisturbed for ten days or a fortnight, and then carefully break open the cells or cocoons and put them in another box on damp moss which has previously been baked in the sun to kill various creatures which may attack the pupæ. This box should be of a good depth so that the moths may have room to open their wings properly when they come out, and the sides and lid should be rough enough to enable them to climb up and get a foothold. It is best to remove the pupæ from the earth, first to make room for fresh caterpillars to pupate, and secondly because it is difficult to keep the earth at the proper degree of moisture. If it is allowed to get too dry, the moth may find it difficult or impossible to make its way out, and if kept too damp, the pupæ may be killed by mildew. Also we wish to describe the different pupæ, and to spot from which pupa any species of moth has come out, if more than one kind is kept in the one box. In most places it is essential to protect the caterpillars and pupæ from ants, or one day we will find half of them eaten. The various tins and boxes can be kept on a table with the legs in tins of water, or better still in tins filled with naphthaline balls. Water may evaporate, or the dog may drink it. Another way is to have hanging shelves with ant-proof guards, as in figure 7.

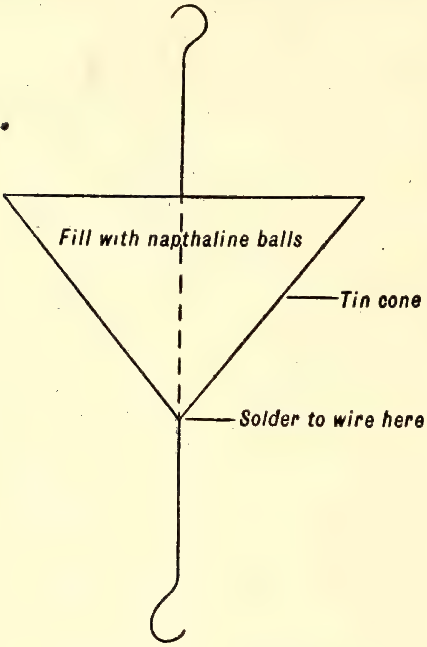


FIG. 7. An ant-proof guard.

The pupal stage may last from a fortnight to several months, according to the species and the time of year. If the pupæ are found in June or July, the moths will probably come out in the autumn, but if formed late in the year, they will not come out till the following spring, or later. Even those pupæ which have not been attacked by parasites in the caterpillar stage are not safe from further attacks. There is a small black fly which attacks healthy pupæ, especially in the Hills. This active little brute gets through the smallest cracks in the box, and lays its eggs on the pupa. Small maggots hatch out and eat the inside of the pupa, leaving only the empty shell, and having finished one will often crawl to the next one and attack it too. In order to protect the pupæ from this pest, the box in which they are kept should be well made, without cracks, and a piece of muslin should be fastened in some way under the lid, with a good overlap. If cracks appear through the warping of the wood, paste muslin over them.

Water should be sprinkled over the moss occasionally to keep it slightly damp and any dead pupæ or empty pupal shells should be removed. When the moth is about to emerge, the pupal shell becomes soft, and in some species transparent, so that the moth can be seen through it and the pupa becomes very lively, squirming vigorously even before it is touched. The shell suddenly splits, and the moth pushes out its head, withdraws its legs, wings, antennæ and tongue from their sheaths, and finally its body from the pupal case. Its body is now soft and flabby and the folded-up wings are limp, useless appendages. The tongue is in two halves, looking like a long tube which has been split longitudinally from end to end, but after a short time the two halves fuse together, forming the tube which is used for sucking honey from flowers.

The moth's one idea is to climb to some position where it can hang by its fore-legs with space below to allow the wings to expand. The wings first hang down back to back, and expand to their full length before they are turned forwards into the normal position, which is either in the same plane as the body or sloping downwards. The moths usually come out after dark, and if left undisturbed, remain motionless, drying and hardening their body and wings, till after dark on the following night. They then start a rapid quivering motion of the wings before darting off in their first flight. They should therefore be put into a killing bottle some time before dark on the evening after they come out, or they will quickly batter their wings to pieces. They should be kept in the killing bottle for some hours before being set or put into envelopes, otherwise they may recover.

Collectors may be employed to bring in eggs and caterpillars. The average plainsman is quite useless at this game, but hillmen, such as the Khasis and the Lepchas are very clever at it. Sometimes they are too clever. Towards the end of one season, when eggs of all but the commonest species, and consequently backsheesh, were getting scarce, one of my Khasi collectors started bringing in eggs on exciting new plants, and was duly rewarded. To my disappointment the young caterpillars would not feed, and one after another died off. Then I noticed that this particular collector's eggs had a funny way of dropping off the food-plant unless carefully handled, and a close examination revealed that Nature had triumphed over Art, and that the gum used by the Khasi for sticking on common eggs was not as efficient as that used by the moth.

In order to get the full value from breeding, it is necessary to keep a careful record and notes. The best way is to give each batch of eggs or caterpillars found on each food-plant a number (I started giving letters, but soon got to *Z* and had to take to numbers). Note the date and locality where eggs or caterpillars were found, when the eggs hatched, when each change of skin was made and so on.

Note the colour, shape and size of the egg, and make descriptions of each stage of the caterpillar, and of the pupa. The moth can be preserved, and it is not necessary to describe it, but there is no satisfactory way of preserving the caterpillar or the pupa in its natural colours. There is a method of '*blowing*' the caterpillars, but it is messy and laborious, and the colours fade. They can be preserved in spirit (see appendix below), but again the colours fade. If we have not the time or the knowledge necessary to make detailed descriptions, the best way is to make a note of the colours, or careful paintings, and then put the specimens into spirit. If these are sent to the Society, complete descriptions can be made later. Photographs are very valuable, and if printed lightly on paper with a matt surface, can be coloured up with water colours. Pupæ can also be preserved in spirit, the colours being recorded separately.

Keep any empty egg-shells, and the cast heads of the caterpillars in glass tubes, with a slip of paper on which their number is written. The empty pupal cases and dried droppings can be kept in match boxes with the number written on them. The moths should be labelled with their number, locality and date of emergence or capture. The food-plants can be pressed, and labelled with their number. If we now send the moths and other specimens to the Society to be named, and also get the food-plants named, we have a complete record. Any parasites which come out can also be kept and labelled with the number of their host. The habits of the caterpillar in its different stages, and also of the pupa and moth should be recorded. In the case of the caterpillar, does it eat the egg-shell; any peculiarities in feeding; in what position does it rest; how does it try to defend itself when alarmed; does it change colour before pupating; does it make a cocoon on the surface or go underground to pupate. Many peculiar habits will be noticed in different species.

In the pupæ note whether the abdominal segments are stiff or flexible; are they lively or sluggish; do they make any noise; is the cremaster free or hooked into the silk of the cocoon.

In the moths note the angle at which the wings are held; do they make any noise; are they active or sluggish; fly by day or by night; do they mate in captivity; any other special habits. The method of keeping a record is shown in the appendix.

Some species of Hawkmoths may be caught when feeding at and after dusk. They are very fond of tubular flowers such as *Petunia*, Tobacco, Railway-creeper and *Plumbago*, and many other garden and wild flowers, and also bushes like *Lantana* and *Duranta.* Some of the day-flying species may be caught feeding in the morning or evening. Some Hawkmoths are attracted by light, and may be caught round lamps. 'Sugaring' does not often attract Hawkmoths, but males may sometimes be caught by putting out a female. A large series of moths may sometimes be bred by a captive female mating with a wild male, or by inducing a pair to mate in captivity when a male and female happen to come out more or less at the same time. The two sexes are usually very much alike, but the female is bigger and has thinner antennæ. It is always worth experimenting with a deformed female to see if she will attract a mate.

The moths, however obtained, may either be set or else kept in envelopes of smooth paper, folded as shown in the appendix. Set specimens take up a lot of room, and in this country are difficult to protect from mould and insects, and are also easily broken when travelling or when sent by post. It is best to set a pair or two of each species for reference, and to put the rest in envelopes to be set later.

LITERATURE.

Very little has up to now been published on the life histories of Indian Hawkmoths. In Moore's *Lepidoptera of Ceylon*, Vol. II (1882-3) there are short descriptions and somewhat crude, coloured pictures of some Hawkmoth caterpillars from Ceylon, most of which are also found in India. In the *Fauna of British India* series, Moths, Vol. I by Sir George Hampson (1892) there are a few text figures of caterpillars. Both Moore's and Hampson's books are very much out of date, the names given to species and the classification having been changed by later writers. In *Biologie und Systematik der sudchinesischen Sphingiden*, by Rudolph Mell (1922) there are good coloured illustrations and photos of many caterpillars and larvæ from South China, some of which also occur in India, and also detailed descriptions of the early stages ; a few species have been described and figured in various Natural history Journals ; and finally the early stages of species common to England and India have been figured and described by many writers (Richard South, Lucas etc.). Rothschild and Jordon, in their great monograph on the Hawkmoths of the world (NOVITATES ZOOLOGICAE, Vol. IX, Supplement (1903), *the Revision of the Sphingidae)* hardly touch on the early stages. The *Macrolepidoptera of the World*, by Adalbert Seitz, is now under publication in English. In this huge work there are good coloured pictures of many Hawkmoths, but none of the early stages, though there are short descriptions of some of the latter. If all the information contained in the above books be extracted, and the descriptions of the early stages of nearly one hundred species bred by a friend and myself (not yet published) be added, there still remain about 60 species of the early stages and habits of which nothing whatever is known. There is thus a wide field open to anyone who takes up the breeding of Indian Hawkmoths. The Society or the writer will be glad to receive any information regarding the occurrence, food-plants and habits of any species, and to give those who are interested any help they can. There are certain species of which only one or two moths have been obtained ; others of which the caterpillars have been obtained, but have died without producing moths, and which therefore cannot be identified. Information regarding localities near Shillong, Mussorie, Dehra Dun and Bangalore with details of food-plants, etc., will be given to members of the Society who are willing to try their hand at breeding, in return for some of the specimens bred. (Address :–Lieut.-Colonel F. B. Scott, I.A., U.S. Club, Simla).

APPENDIX

PAPER ENVELOPES.

Take pieces of smooth paper of oblong shape and different sizes. Fold across as shown in Fig. 8 and then turn the ends over to make triangular envelopes. Take a moth from the killing bottle and choosing an envelope of suitable size, put the moth into it in the position shown in Fig. 9, with the antennæ folded back to protect them from injury. Write the number of the moth, locality and date of emergence or capture on the flap, and pack the envelopes fairly tightly into a box with naphthaline balls or powdered naphthaline. If kept in a damp climate, keep a sharp lookout for mildew.

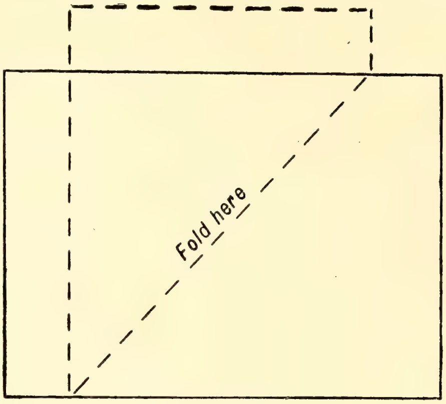


FIG. 8.

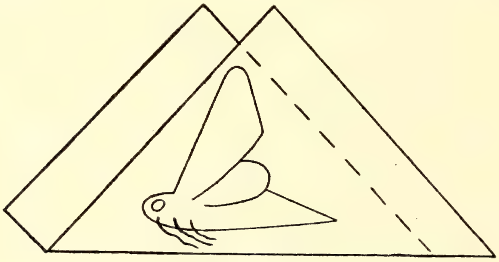


FIG. 9.

SET SPECIMENS.

The store-boxes in which set specimens are going to be kept can be treated as follows to protect the specimens from insects. Dissolve naphthaline in petrol and pour it all over the inside of the box. The petrol will evaporate and leave the naphthaline as a fine deposit. If set specimens are attacked by mildew put a few drops of pure carbolic acid onto small balls of cotton-wool, and pin the balls near the affected specimens. The bodies of Hawkmoths sometimes become greasy, and if not attended to the grease may spread over the whole specimen. Treat by soaking the whole moth in petrol till all the grease has been dissolved, or break off the body, soak it in petrol and replace in position with cement. When travelling cross-pin the body of each moth. Set the moths high up on the pins so that the pins can be driven well into the cork of the store-box, and so that the specimens, being well raised, are less liable to attacks of insects and mildew.

PRESERVING IN SPIRIT.

Make up a bottle of spirit as follows :—

Alcohol (90 per cent), three parts ; water, two parts ; glycerine, one part.

Put the specimens into glass tubes of suitable size, with a slip of paper on which the necessary data is written in pencil. Pour in the spirit, cork tightly, and seal the cork with sealing wax. A plug of soft paper should be placed on top of the specimen in each tube to prevent injury from shaking or washing about.

NAMING FOOD-PLANTS.

In order to get food-plants named they should first be pressed. Special botanical paper can be obtained for this purpose, but newspaper or brown paper does very well. Whenever possible flowers or fruit should be pressed with the plant. Small plants can be pressed complete with roots. Larger plants can be pressed with part of the stem removed. In dealing with trees and shrubs press a twig with leaves, and flowers or fruit attached or separate. Label each plant with its number and locality. When pressed and dry, the plants can be sent to the Forest Research Institute, Dehra Dun, or some other authority. Botanists are usually pleased to receive and name well-pressed specimens.

HOW TO KEEP A RECORD.

No. 23. [the serial number of the species].

Deilephila nerii, Linnæus. The Oleander Hawkmoth [name given by the Society].

Locality. Allahabad (in the hills, elevation etc.).

Food-plant. Nerium odorum, Soland. The Oleander [name given by the Forest Research Institute or other authority].

Egg. Date when found, colour, shape, size in millimetres.

Egg-caterpillar:—Describe, or put in spirit.

After first, second, third, etc., changes of skin, describe or put in spirit.

Pupa. Describe or put in spirit.

Moth. Set or put in envelope.

Habits of caterpillar, pupa and moth. Any other remarks such as common or rare, local, etc.

If possible, take one or more eggs and record :—

Date egg was found or laid.
Date on which caterpillar hatched.
Date of each change of skin.
Date caterpillar stopped feeding.
Date caterpillar left food-plant.
Date pupa was formed.
Date moth emerged.

No. 32. *Celerio euphorbiæ*, Linnæus. The Spurge Hawkmoth.

Locality. Changla Gali, 9,000 feet.

Caught when feeding on flowers at dusk on (date).

No. 34. *Hippotion rafflesi*, Butler.

Locality. Nandidroog, Bangalore. 3,000 feet.

Caught in bungalow at 10 p.m. on (date).

A NOTE ON THE BIRDS IN THE NEIGHBOURHOOD OF MHOW.

BY

Rev. F. S. Briggs.

The following notes are mainly from my own observations, made while stationed at Mhow, Central India, from March 1927 to October 1929, but, for the sake of completeness, I have added whatever notes on this area I have been able to find elsewhere.

My thanks are due to Mr. Hugh Whistler for identifying many of my specimens, and for checking my identification of others, also for many valuable suggestions. I also wish to thank General Betham for information with regard to certain species of birds which he found breeding near Mhow.

Most of these notes refer to the country within twelve miles of Mhow, but I have also included a few observations made at a greater distance, particularly in the neighbourhood of Barwani in the Narbadda Valley.

The country round Mhow falls into two divisions. First, the Vindhya Hills. Secondly, the Malwa Plateau. The Vindhya Hills are mostly covered with jungle, and intersected by deep and steep-sided ravines. The Plateau is largely under cultivation, but there are also on it stretches of rolling grass-land, particularly where it merges into the Vindhyan range.

The Raven. Corvus corax (Linn).

One seen in barracks at Mhow, 2-10-28.

The Jungle Crow. Corvus coronoides Gould. ♀ 7-2-28, ♂ 9-2-28.

Common in every type of country, but the majority seem to leave the Cantonment for breeding purposes. A nest containing fully fledged young was found on June 29, but young birds able to fly were seen as early as May 5.

The Indian House Crow. Corvus splendens splendens (Vieill.).

Commoner than the last species in Cantonments, less common away from houses, but, like the last species, many appear to leave the Cantonment area to breed. Eggs are laid in June. One was seen with a white crescent on the throat and a narrow white line round the neck, the latter concealed except when the bird stretched its neck, 23-8-27.

The Indian Tree-Pie. Dendrocitta rufa (Latham). ♂ 7-9-27.

Common at all times in scrub jungle. In winter a fair number invade the Cantonment.

Grey Tit. Parus major mahrattarum Hartert. ♀ 5-3-28, ♂ 2-7-28.

The former specimen was obtained from a flock of four or five, the latter was alone, and was in full breeding condition. Both specimens were obtained at the foot of the Vindhya Hills.

The Yellow-cheeked Tit. Maclolophus xanthogenys (Vigors).

This species is fairly common. Most of them appear to leave the Cantonment during May, June, and July, presumably for breeding. During the rest of the year they are common garden birds. A nest was found on June 29 about forty feet up a Peepul outside the Cantonment. Young birds left the nest the following day.

The Chestnut-bellied Nuthatch. Sitta castaneiventris (Frank). Jerdon states (*Birds of India*, Vol. I, p. 386) that this species occurs 'In the Vindhyan Range of Hills.' I did not observe it.

The Jungle Babbler. Turdoides terricolor (Hodgs.). ♂ 28-7-27, ♂ 29-3-28, ♀ 9-11-28.

Fairly numerous within the Cantonment; only occasionally seen elsewhere. They seem to form strong local attachments. In some gardens, one can be fairly certain of seeing a flock of them, while there are other gardens which they never seem to enter. One flock, also, is always to be seen in jungle about a mile below Simrole, though, as a rule, they belie their name by rarely being seen in jungle. They breed throughout the rains, and possibly at other times of the year as well, but most eggs appear to be laid in July. The three above-cited specimens are intermediate between *T. t. terricolor* and *T. t. sindianus*, but nearer the latter than the former.

The Common Babbler. Argya caudata caudata (Dumont). ♀ 30-1-28.

This species is singularly scarce, and local in its distribution. In the swamp below the bund at Bircha, a flock is always to be found, and I have seen pairs further up the Bircha Valley, and by the Ghambier River for about six miles below its source in the above-mentioned swamp. I have seen them nowhere else near Mhow, though they are common in the Narbadda Valley, especially near Barwani. Eggs found as early as March 17, and young birds in the nest as late as October 24. All the nests found were in low date-palms, amongst the fronds, at the point where they spring from the trunk.

The Large Grey Babbler. Argya malcomi (Sykes).

Quite the most numerous member of the family near Mhow. It rarely, if ever, comes near houses, preferring scrub-jungle and roads lined with acacia trees. In scrub-jungle it is always the first bird to give warning of the approach of an intruder, and causes a good deal of annoyance to naturalists and sportsmen by alarming other species with its call. Its flocks sometimes number as many as forty, and flocks of twenty are common. Eggs are laid in February and March, and again after the breaking of the rains, in June and July. The majority of nests are situated in acacia trees, at any height up to fifteen feet from the ground. On August 5 a pair were seen with a juvenile Pied Crested Cuckoo, which was being fed by them on open ground near the village of Gowlipura. Jerdon states that this species is 'Rare at Mhow.' (*Birds of India*, Vol. II, p. 65.). There must have been an increase in the species since his day.

The Rufous-bellied Babbler. Dumetia hyperythra (Frankl.). ♂ 25-6-29.

The one specimen obtained was in full breeding condition. A few individuals of this species were seen on several occasions at different seasons in Jungle at the foot of the Vindhya Hills on the Northern side of the range, near the Bombay Road. None were noted elsewhere. The following is a quotation from *On the Birds of Central India*, by Lt.-Col. C. Swinhoe and Lt. Henry Barnes[1] (Ibis 1885, pp. 52–69; 124–138). 'At present we have obtained it' (i.e. *D. hyperythra*) 'at and in the vicinity of Mhow only, in March 1882 and December 1881.'

The Yellow-eyed Babbler. Pyctorhis sinensis (Gmel.). ♂ 5-3-28.

Resident in small numbers in the swampy ground below the bund at Bircha. Mixed flocks of this species and *Argya caudata* were seen there on several occasions.

The Central Indian Iora. Ægithinia tiphia humei Stuart Baker. ♂ (juv.) 5-8-27.

Not uncommon, but erratic in its appearance. It occurs both in gardens and in scrub jungle, but rather more often in the latter type of country than in the former. It breeds about the beginning of the rains, i.e. during the latter half of June and the first half of July, but males assume their breeding plumage in April. The male takes his share in the duties of incubation, and one was observed sitting on a nest and singing vigorously on June 25th.

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[1] Henceforth referred to for brevity as S. & B.

Jerdon's Chloropsis. Chloropsis jerdoni (Blyth).

'Found at Mhow.' (Jerdon, Vol. II, p. 98.)

The Central Indian Red-vented Bulbul. Molpastes hæmorrhous pallidus Stuart Baker. ♂ 3-8-27, ♀ 13-2-28, ♂ 29-12-28, ♀ 25-2-29.

Numerous in every type of country except thick jungle. In winter, they gather in flocks up to a dozen or more in strength, but within the flocks, appear to keep largely in pairs. These flocks invade gardens during the winter, beginning to disintegrate early in March. A few individuals remain in gardens all the year, and breed there, but scrub jungle appears in this area to be their favourite type of country for breeding. Eggs found between May 6th, and September 5th. The subspecific name *pallidus* covers all birds intermediate between *intermedius*, *bengalensis* and *hæmorrhous*; but the Mhow specimens are nearer to *hæmorrhous* than to the two former races.

The Spotted-grey Creeper. Salpornis spilonotus (Frank).

Lt. Young states that he shot one near Mortakka on April 4th. (*J.B.N.H.S.*, Vol. XVI, p. 514).

The Northern Indian Pied Bush-Chat. Saxicola caprata bicolor (Sykes) ♀ 5-10-28, ♂ 27-10-28.

A winter visitor, not very numerous, seen chiefly in open country and swampy ground. Earliest and latest dates seen; September 23 and March 25. There seems to be some misconception about the status of this bird. The *Fauna*, (2nd edn., Vol. II, p. 27,) states :—' . . . is a resident almost throughout its habitat but it seems to leave its highest ranges in winter, and in some places moves locally from the plains to the adjacent hills for breeding purposes.' From my own small experience, its movements seem to be more marked than is here suggested. In the Peshawar valley it is mainly a summer visitor, though a few individuals spend the winter there. In the same area it has also a secondary movement from the Valley to the surrounding hills *after* breeding, and before moving south for the winter. Round Mhow it is, both on the Plateau and in the Vindhya Hills, purely a winter visitor. At Poona it is common in the winter, but leaves before the summer. There, however, the movement may be only local, as it breeds in considerable numbers round Khandala, less than forty miles away. Mr. Hugh Whistler states that 'It is a very marked summer visitor throughout most of the North-West, but here and there a few individuals are resident.' From these notes it appears to be very largely a migratory race.

The Stone-Chat. Saxicolor torquata (Linn.). ♂12-12-27, ♀ 23-1-28, 0? 14-9-28. (juv.).

A winter visitor, much more numerous than the last species.

It is to be found wherever there are not too many trees, but chiefly in swampy and rocky country. Earliest and latest dates seen : September 9, and March 25. The three species, none of which were obtained in swampy ground, belong to the race *indica*. But Jerdon states, (J., Vol. II, p. 130), with reference to *Saxicola leucuroides* (=*Saxicola torquata leucura*), that it is 'Not uncommon about Mhow in the cold weather.' Both races, therefore, appear to occur.

The Pied Wheatear. Œnathe picata (Blyth). ♂ 1-10-28.

The above-mentioned specimen, obtained about a mile south of Mhow on the Bircha Road, and a female seen a few weeks later on the road to Indore are the only records I have of the species in the area.

The Wheatear. Œnanthe œnanthe œnanthe (Linn.).

'I got a specimen near Mhow in the cold weather.' (J., Vol. II, p. 132).

Gould's Desert Wheatear. Œnathe deserti atrogularis (Blyth.) ♂ 10-2-28.

My only other record is of one seen about mile 14 on the Neemuch Road, 12-11-28. Jerdon, however, states (J., Vol. II, p. 133) :—' Common at Mhow in the cold weather.'

The Brown Rock-Chat. Cercomela fusca (Blyth).

A pair seen in Mhow itself 22-1-29. It seems strange that this should be the only record of so common a bird.

The Black Redstart. Phœnicurus ochrurus phœnicuroides (Moore).

A common winter visitor. Earliest and latest dates seen : Sept. 17 and April 10. This species seems to form strong local attachments. One can be fairly certain of seeing an individual within a few yards of certain trees, once one has learned where to look. The same trees are favoured year after year. Males always appear greatly to outnumber females. As the male is for the first year exactly like the female in appearance, and breeds in that immature dress, one would expect the reverse to be true. It would appear, therefore, that most of the females and immature males migrate to some other locality from that favoured by the males. They are very bold, and in the autumn of 1928 one frequently came into my bungalow to catch insects, and on one occasion was catching them in the church throughout the morning service, entirely undisturbed by the singing of the congregation.

The Eastern Red-Spotted Bluethroat. Cyanosylvia suecica pallidogularis (Saruday). ♀ 30-1-28.

Not uncommon, particularly in reed-beds, during the winter. It arrives late and departs early, its earliest and latest dates being Oct. 1 and Mar. 25.

The Brown-backed Indian Robin. Saxicoloides fulicata cambaiensis (Lath.).

Common and resident, in gardens, cultivation, and scrub-jungle. Eggs are laid in April, and probably up to the middle of June.

The Magpie Robin or Dayal. Copsychus saularis (Linn.).

This species is fairly common in gardens and cultivation. On several occasions I noticed the female singing to the male. No nest of the species was found, but very young birds, which had evidently only just left the nest, used to make their appearance in the middle of July. This species resents the presence of members of the last species in any garden in which it has taken up its abode, and does its best to drive them off, attacking them with great vigour.

The Dark Thrush. Turdus obscurus Gmel.

A bird which was taken for this species was seen on the Ghambier River on the outskrits of Mhow, on the evening of 2-2-29. This was during a spell of phenominally cold weather which was making itself felt over the whole of Northern India. The bird seemed very tired, but I was unable to obtain it as a specimen, so the identification must be regarded with suspicion.

The Indian Blue Rock Thrush. Monticola solitaria pandoo (Sykes). ♀ 2-4-28.

A winter visitor in small numbers, in addition to which many pass through on the Spring migration. Females seem to be more numerous than males. Earliest and latest dates : Oct. 16 and Apr. 1.

The European Red-breasted Flycatcher. Siphia parva parva (Bechst.). ♂ 6-2-28.

Mainly a passage migrant in October and April, but a few seem to winter in the district. Red-breasted males are greatly in the minority. The one specimen obtained belonged to the typical race. Earliest and latest dates : September 24 and April 17.

Tickell's Blue Flycatcher. Cyornis tickellii (Blyth).

Not uncommon in the Vindhya Hills, both in scrub and in thicker jungle. General Betham took their eggs in the valley below Simrole in May. A pair were seen courting in the same valley in June.

The Verditer Flycatcher. Stoparola melanops (Vigors).

One seen in garden 30th November 1928. 'Mhow and Manpore are at present the only places where we have obtained it' (S. & B.).

The Brown Flycatcher. Alseonax latirostris (Raffl.).

General Betham took the eggs of this species in the valley below Simrole. I did not see any birds of this species in the Mhow district, but a bird described to me by a careful observer appeared to belong to this species. S. & B. record having obtained a single specimen at Manpore.

The Paradise Flycatcher. Terpsiphone paradisi (Linn.).

This species seems to be resident in small numbers in the Vindhya Hills, and to occur as a passage migrant on the plateau. General Betham took eggs in the valley mentioned above. My own observations of the species are not very numerous, so may be given *in extenso*.

1927	Mar. 27.	Male in mixed chestnut and white plumage opposite bungalow.
	May 28.	Several females by Simrole Road.
	Sep. 21.	Numerous, both sexes, Jeshwantnagar.
	Oct. 12.	Several below Simrole.
1928	Apr. 5.	One adult male, Indore.
	June 22.	Female in Jungle about two miles S. of Simrole Road.
	Sep. 10.	Females (or Juveniles) numerous at Jeshwantnagar.
1929	Mar. 25.	One adult male Bircha.
	June 12.	Female by Ghambier River.
	July 3.	Adult male with ribbon feathers missing, Fort *glacis*.
	Sep. 27.	Female, Mile 7 on Bombay Road.

The White-browed Fantail Flycatcher. Rhidipura aureola (Less.).

Fairly common, and resident, but subject to local movement. In the spring and summer they are common along the road between Mhow and Simrole, and in the scrub-jungle to the south of the road, but do not appear to occur anywhere else in the district. During the winter they spread over the whole district frequently coming into gardens. On several occasions in the winter pairs of them were seen feeding with a flock of *Phylloscopus collybitus tristis*. Breeding appears to commence about the middle of February.

The Indian Grey Shrike. Lanius excubitor lahtora (Sykes). ♀ 17-6-27.

Seen at all times of the year, but in distinctly greater numbers in summer than in winter. It is mainly a bird of open grazing grounds and roads sparsely lined with trees, particularly *Acacia*. The one specimen obtained showed some signs of breeding, and a nest containing fresh eggs was found on April 17, but breeding appears to take place mostly in the rains.

The Bay-backed Shrike. Lanius vittatus (Valenc.). ♂ 21-12-28.

The one specimen obtained was in juvenile plumage. This is by far the commonest shrike about Mhow. It is even more numerous in winter than in summer. Breeds during the rains, and usually has two broods.

The Rufous-backed Shrike. Lanius schach (Linn.). ♂ 31-10-27; ♂ 28-11-27; ♀ 16-6-28.

The above specimens are all intermediate between *erythronotus* and *caniceps*, and cannot be assigned definitely to either race. Nests containing eggs found between June 16 and Aug. 20. All the nests found round Mhow were much less bulky and contained less wool than those I have seen in the Peshawar District and in Kashmir. The species is not very common about Mhow at any time, but there is a noticeable increase in numbers in the autumn.

The Brown Shrike. Lanius cristatus (Linn).

Seen very occasionally in winter and early spring. Also recorded from Mhow by S. & B.

The Indian Common Woodshrike. Tephrodornis pondiceriana pondiceriana (Gmel.). ♂♂ 19-6-28, ♀ 15-10-1928.

Fairly numerous in scrub-jungle, but rather erratic in its appearances. Rarely seen in winter. One of the two specimens obtained on June 19 was a juvenile which could not very long have left the nest, and was still being fed by its parents.

The Small Minivet. Pericrocotus peregrinus (Linn.) ♂ 26-10-27 ; ♀ 16-11-27.

Common and resident, but, like the rest of the minivets, wanders a good deal in small parties in search of food. It breeds in March, and apparently again in the earlier part of the rains. On one occasion a pair of females were seen fighting very fiercely for the favour of a male, who looked on with apparent interest, but took no part in the dispute.

The White-bellied Minivet. Pericrocotus erythropygius (Jerdon). ♀ 9-5-28.

This species was numerous on the road to Bircha on the day the specimen was obtained and two days later. It was occasionally seen again, each time either in spring or in autumn. It may therefore be regarded as a passage migrant only in this area.

The Large Cuckoo-Shrike. Graucalus macei (Less.).

Status uncertain. From September to May it is a common bird in gardens and in cultivated country wherever there are tall trees. Nearly always they are seen either in twos or threes, but I have one record of a flock of six. Between May and September I have only five records of this species in the area. They are as follows :—

1928	July 9.	One in thick jungle, S. of Mhow, Simrole Rd.
	July 10.	Do. do.
1929	June 11.	Three seen beyond polo-ground.
	July 8.	One in same place as previous July.
	Aug. 6.	One west and one east of polo-ground.

The behaviour of those seen in July in both years suggested that they had nests, though I was unable to find them. On September 27, 1930, a pair were flying round what appeared to be a half-finished nest about forty feet up in a Peepul tree on the outskirts of Mhow. Twice while I watched, the female flew away with a little of the material of the nest in her bill. The next day all the material had disappeared. As it was in a position quite inaccessible to a human being it may be assumed that the birds had themselves removed it all. On October 8, a pair were seen courting vigorously in a tree at the side of a road in Indore. From the above observations it would seem probable that this species is mainly a winter visitor to the immediate neighbourhood of Mhow, and makes a local migration, probably to the jungles of the Vindhya Hills, for breeding, but that they may sometimes breed a second time later in the year on the plateau.

The Black Drongo or King Crow. Dicrurus macrocercus (Vieill.).

Numerous at all times, but even more numerous in winter than in summer. Breeds mainly in June and July.

The Ashy Drongo. Dicrurus leucophæus (Vieill.).

S. & B. procured specimens at Mhow in October.

The White-bellied Drongo. Dicrurus cærulescens (Linn.).

Only occasionally seen. It appears to be resident in small numbers, and is local in its distribution. The one place where one can generally be fairly certain of seeing several is over the river at Indore. Its notes are similar to those of the King Crow, but much less harsh than the usual call of the latter, and more like its softer, early-morning call.

Acrocephalus.

'A note on the Asiatic Members of the Genus *Acrocephalus*' by Mr. Hugh Whistler (The *Ibis*, July 1928, pp. 449-453) suggested the possibility that some members of that genus not yet recorded as breeding in the plains of India, may actually do so. Hence I spent some considerable time in reed-beds looking for the nests of Reed-Warblers. The results were interesting but inconclusive. A fringe of reeds grows along the side of the overflow from Bircha Lake. In these reeds I found the only trace in the district of *Acrocephali* breeding. On August 5, 1928, there were two nests, both of them typical Reed-Warbler nests, in these reeds. One was slung between about four reed-stems; the other was attached to a reed-stem and to two or three thorny, upright branches. The former nest was empty, and the latter contained one egg, strongly reminiscent of the egg of *Sylvia atricapilla.* I left it in the hope that more would be laid, and that I might see the parent birds. On examining the nests a few days later, however, I found both empty. In 1929, I again kept my eye on the same fringe of reeds. In August, I again found a nest exactly similar in all respects to the nest I found in the preceding year. On August 9, when I was looking at it, a small bird which might quite well have been a Reed-Warbler was showing great anxiety in some bushes behind the nest. As the nest was empty, however, I went away at once so as not to frighten the owner. I visited the nest on several subsequent occasions, without, however, finding any eggs.

Pallas's Grasshopper Warbler. Locustella certhiola (Pall.).

Jerdon says that he met with it in 'Long grass in the neighbourhood of Mhow, during the rains.' (Jerdon, Vol. II, p. 159).

The Tailor-Bird. Orthotomus sutorius (Forst.).

Very common and resident. There appears to be at least one pair of these birds to every garden, besides which they are numerous in scrub-jungle. They breed from June to the end of September, and appear usually to have two broods. Some writers state that it is the hen Tailor-Bird that does all the work in building the nest. In the case of three nests built in my garden at Mhow, the male did the greater part of the work of sewing the leaves together, and each took a share in building the nest itself. Two nests built in the summer of 1929 were lined almost entirely with bits frayed off from a rope for opening and shutting one of the *roshandans* of my bungalow. The eggs were taken from the former of these nests, probably by a squirrel, and the male Tailor-Bird was seen removing a good deal of the lining to use on a second nest about twenty yards away.

The Streaked Fantail Warbler. Cisticola juncidas (Rafinesque). ♀ 30-1-28.

Fairly common, but rather erratic in its appearances and disappearances. It is generally to be seen at Bircha.

Franklin's Wren-Warbler. Franklinia gracilis (Frankl.). ♀ 15-8-27, ♂ 2-7-28.

Fairly common and resident. This species is chiefly found in bushes by the side of roads, and in gardens. Breeds in the rains. A pair seen feeding fairly well-grown young on 21-8-29.

The Rufous-fronted Wren Warbler. Franklinia buchanani (Blyth).

Jerdon states that he obtained a specimen near Mhow. (Jerdon, Vol. II, p. 187.)

The Booted Tree-Warbler. Hippolais scita (Eversm.). ♂ 4-4-28.

The above-cited specimen was excessively fat, suggesting that it was on the point of migrating. The species was not identified on any other occasion.

Hume's Lesser Whitethroat. Sylvia althæa Hume. ♀ 1-10-28.

This specimen was obtained from a flock of three or four. No other record.

The Desert Warbler. Sylvia nana (Hemp. & Ehr.).

'Found at Mhow.' (Jerdon, Vol. II, p. 209).

The Indian Lesser Whitethroat. Sylvia curruca affinis (Blyth). ♂ 31-10-27, ♀ 14-11-27.

Very numerous on passage in the spring and autumn, a considerable number also wintering in the neighbourhood of Mhow. It is chiefly found in open scrub-jungle with plenty of acacia bushes, but also occurs in gardens.

The Siberian Chiffchaff. Phylloscopus collybita tristis (Blyth). ♂ 28-12-27, ♂ 9-1-28.

Occurs fairly plentifully in winter in small flocks. On several occasions a flock of this species was seen following a pair of Fantail Warblers about and feeding with them. They occur in every type of country.

The Olivaceous Willow-Warbler. Phylloscopus indicus (Jerd.). 0? 15-10-28.

The above specimen was obtained from a flock feeding in trees near Jeshwantnagar. They ran about the trunks and branches searching the bark for insects in the manner of Tree-Creepers.

The Greenish Willow-Warbler. Phylloscopus nitidus viridanus (Blyth.) ♀ 10-9-28.

This specimen, obtained from a mixed flock of *Phylloscopi* feeding in the trees overhanging Jeshwantnagar Lake, is the only record.

The Streaked Wren-Warbler. Prinia gracilis (Licht.).

'Abundant on the Vindhya Mountains near Mhow.' (Jerdon, Vol. II, p. 172).

Stewart's Ashy Wren-Warbler. Prinia socialis stewarti (Blyth).

Fairly numerous and resident, rarely seen far from water. The only nests found were of the Tailor-Bird type, and always close to a stream. Breeds about the end of March and the beginning of April, and again in the rains (August).

The Indian Wren-Warbler. Prinia inornata inornata (Sykes). ♂ 29-7-27, ♀ 21-9-27, ♀ 8-6-28, ♂ 17-9-28.

Numerous and resident. It is always commoner near water than elsewhere, but also occurs in cultivation well away from water. Every nest found was close to water, the majority being either in reeds or in Marestail. By far the greater majority of eggs are laid in the last fortnight in August, but a few are laid in September.

The Indian Oriole. Oriolus oriolus kundoo (Sykes).

This species occurs at all seasons, but is distinctly more numerous in spring and autumn than either in summer or winter. It breeds in May.

The Indian Black-naped Oriole. Oriolus chinensis indicus (Jerdon).

'One seen at Manpore in June 1882.' (S. & B.).

The Rose-coloured Starling. Pastor roseus (Linn.).

In March 1927 I saw several large flocks. In the two succeeding years their numbers were much smaller. Flocks were also seen four times in April, twice in February, and once in January. On 11-3-29 a mixed flock, consisting of five Common Mynahs and three Rose-coloured Starlings flew over the *glacis* of the fort.

The Black-headed Mynah. Temenuchus pagodarum (Gmel.).

Fairly numerous. There seems to be a slight increase in numbers before the breeding-season, which extends from the middle of April to the middle of June.

The Common Mynah. Acridotheres tristis tristis (Linn.). ♂ 28-7-27.

Very common and resident. Eggs laid about the middle of July. A young bird, not quite fledged, which had fallen from its nest was picked up in August 1928, brought up by hand till it was big enough to look after itself, and then released. It visited the bungalow daily till about April, generally timing its visits to coincide with meal-times. It showed a strong dislike to anything containing chocolate, but otherwise would eat anything, and its great partiality for all dairy products, especially cream and cheese, made it necessary to keep a very wary eye on those articles when he was about. He was entirely fearless, and walked about the table during meals. In April he disappeared, but reappeared, rather to our surprise in September, continuing to haunt the house with the same persistence and fearlessness till we left Mhow at the end of October.

The Bank Mynah. Acridotheres ginginianus (Lath.).

'I got it at Mhow, ... though rare, and on the banks of the Narbadda.' (Jerdon, Vol. II, p. 327).

The Baya or Weaver-bird. Ploceus philippinus (Linn.). ♂ ♀ 19-5-28, ♀ 26-12-28, ♂ ♂ ♂ ♂ 14-6-29, ♂ 29-6-29.

Common and resident. The ♂ obtained on 19-5-28 was just beginning to assume breeding plumage; the four specimens obtained on 14-6-29 were in varying stages of moult, but all nearly in complete breeding plumage; and the last specimen was in complete breeding plumage. Their second moult appears to take place immediately after breeding, but I obtained no specimens to illustrate it. Work on nests is begun before the end July, but the earliest date on which I have found eggs is September 7. The latest date on which I found eggs was October 1st. Several books state that there is never any lining in a Baya's nest. Every nest I examined in the neighbourhood of Mhow had at least a few feathers, and in several cases the eggs were resting on a thick mat of feathers. In one or two cases the feathers were white, but usually, they were pale grey.

The White-throated Munia. Uroloncha malabarica (Linn.). ♂ 3-8-27.

Resident, but subject to local movement in accordance with the supply of food. They breed irregularly from August to April, but the majority of eggs are laid in January and February.

The Green Munia. Stictospiza formosa (Lath.).

A few of these very beautiful little birds were seen in a large flock of Amadavats near Killod, South of Mhow, 8-6-28. Jerdon says (Vol. II, p. 361):—'Occasionally caught and caged . . . . at Mhow.'

The Amadavat. Amandava amandava (Linn.).

A flock of about fifty seen near Killod, 8-6-28. No other record.

The Common Rose-Finch. Carpodacus erythinus (Pall). ♀ 9-11-28.

Winter visitors. A large flock seen 9-11-28, otherwise only one or two individual birds.

The Yellow-throated Sparrow. Gymnoris xanthocollis xanthocollis (Burton). ♀ 12-12-27; ♂ 20-2-28; ♂ 28-5-28; ♂ 19-6-28.

The status of this species is somewhat puzzling. About the end of February, they begin to build in considerable numbers, and by the end of April, young birds begin to appear. In May they cease to be evenly distributed over the countryside, and gather into flocks usually of about a dozen to twenty individuals. These flocks are seen mainly in scrub-jungle. Soon after the rains break, (i.e. about the end of June or beginning of July), they entirely disappear and I have only one record of the species in July, (9-7-29), and none at all for August or September. In 1927 the first occasion on which they were recorded after their departure in the early rains was November, 6th, two days after heavy and unseasonable rain. They were again seen on the 7th, 8th, 23rd, and 24th, of the month, each time in small parties. In December they were seen four times, each time in large flocks. In January they were fairly frequently seen, generally in smaller flocks than in the preceding month, and before the end of the month they were beginning to sing and fight. Throughout February they were very frequently seen but in very varying numbers, the impression given being that flocks of them were passing through the district, while some individuals were settling down to breed. A male shot on February 20, was in full breeding condition, and they were seen carrying building materials on February 29. In 1928 their appearance after the rains was earlier than in 1927. On October 19 and 20 they were very numerous fifty miles south of Mhow, beyond the Narbadda River, and on the 21st, one was seen at Mhow. From that date till October 29 the notes correspond pretty closely with those already given. The above observations suggest that the breeding birds leave Mhow for the rains, and that there is an influx of other individuals of the species, possibly those which have bred in the Punjab, in the winter. If these winter visitors do come from the Punjab, however, they must delay a long time on the way, as they are amongst the first summer visitors to leave the Punjab.

The Indian House-Sparrow. Passer domesticus indicus (Jard. & Selby).

More numerous in the bazar than elsewhere, but by no means as numerous about Mhow as in many other parts of India. Breeds irregularly almost throughout the year.

The Grey-headed Bunting. Emberiza fucata Pall.

'Seen at Mhow.' (Jerdon, Vol. II, p. 276).

The Grey-necked Bunting. Emberiza buchanani Blyth. ♂ 6-2-28.

A pair were seen in scrub below the fort on April 25 and 26, 1929. Otherwise the above-cited specimen obtained in scrub near Bircha Lake, is my only record of this species.

The Red-headed Bunting. Emberiza icterica Eversm.

'Tolerably abundant at Mhow.' (Jerdon, Vol. II, p. 379).

The Crested Bunting. Melophus melanicterus (Gmel.).

Appears to be a summer visitor in considerable numbers to the Vindhya Hills. Only seen once in winter, 8-12-28, when a small party of one adult male and a few hens or immature birds were seen feeding in the long grass on the bund of Bircha Lake. General Betham states that he twice took the egg of *Cuculus canorus* from the nest of this species near Simrole.

The Sand Martin. Riparia riparia (Linn.).

'Saw it occasionally at Mhow.' (Jerdon, Vol. I, p. 163).

The Dusky Crag-Martin. Ptyonoprogne concolor (Sykes).

Fairly numerous in summer, much less so in winter. Eggs laid in August and September. Nests placed both on cliffs and buildings. Lt. Young found young birds of this species in nests in the Narbadda Valley in April (*J.B.N.H.S.*, Vol. XVI, p. 315). This suggests the question as to whether the species breeds twice; once in the Narbadda Valley in the spring, and once on the Plateau in the latter part of the rains.

The Common Swallow. Hirundo rustica Linn.

Occurs in immense numbers on passage in the autumn, and is occasionally seen throughout the winter. Only one record in the spring, *viz.* Indore, 12-3-27.

The Indian Wire-tailed Swallow. Hirundo smithii filifera (Stephens).

Resident in considerable numbers. Eggs found at various times between February 17 and September 25. The same nest was used in April and September 1927, and in February and May 1928. The last time the nest was used, it cracked off the cliff to which it was attached, presumably owing to the dry heat, when containing two young birds nearly ready to fly, but caught on a projecting root, where it remained till the young left some days later.

The Indian Cliff Swallow. Hirundo fluvicola Jerdon.

Occasionally seen, chiefly in winter. A very large colony breeds on the piers of the railway bridge over the Narbadda at Mortakka, about thirty miles from Mhow in July. Apparently they breed twice in the year in the Narbadda Valley, as Lt. Young (*J.B.N.H.S.*, Vol. XVI, p. 515), states that on April 9 he examined a colony of these birds, and found that most of the young had just left the nests.

Hodgson's Striated Swallow. Hirundo daurica nepalensis (Hodgs.). ♀ ♀ ♀ 25–1–29.

The three specimens were all *nepalensis*. The winter birds look different from the breeding birds, and probably belong to a different race. The breeding birds arrive in May, and breed during the latter part of the rains. Nests containing young having been found from August 25 to October 12. The one nest found on the latter date contained one nearly fledged bird, which appeared to have been deserted by its parents. During the latter half of October I have no record of this species for any of the three years. There is a great influx of Striated Swallows about the beginning of November, and they occur in large flocks during that month, December and January. No records of the species for February, March, or April.

The Indian White Wagtail. Motacilla alba dukhunesis (Sykes). ♀ 7–11–27, ♀ ♀ 5–10–28.

The commonest of the migratory Wagtails. They are to be seen in immense numbers every evening in the winter on the polo-ground, where they appear to be entirely undisturbed by any match which may happen to be in progress, merely flying up when the ponies approach very close to them, and settling again at once. About sunset they fly off in flocks in a south-easterly direction. Earliest and latest dates seen : September 21, and April 7.

The Masked Wagtail. Motacilla alba personata (Gould).

One seen on the roof of the post office, 6–12–28.

The Large Pied Wagtail. Motacilla maderaspatensis (Gmel.).

Several pairs are resident at Bircha, where they breed in a punt and on the pumping station in the hot weather, and the rains. Rarely seen elsewhere.

The Grey Wagtail. Motacilla cinerea Tunstall.

Presumably this is *caspica*, but no specimen was obtained. This is usually the earliest of the migrant Wagtails to arrive, and the latest to depart. Earliest and latest dates September 6 and April 29. On 13–9–27, one adult and two juveniles were seen together. This is the least social of the migratory Wagtails, never occurring in large flocks. Individual birds seem to occupy a certain very restricted area for the winter, and, once they have settled down, may be seen daily in the same place.

The Indian Blue-headed Wagtail. Motacilla flava beema (Sykes). ♀ 1–10–28, ♂ 5–10–28, ♂ 24–10–28, ♂ 30–11–28.

Seen from the end of September till March. They occur in flocks, generally near water and in swampy ground, but sometimes on dry pasture-land. Frequently they are found in mixed flocks with *M. alba*. They appear to roost in great numbers on the open ground on One Tree Hill. Considerably more numerous on the autumn passage than, later on, in the winter or on the spring passage.

The Western Yellow-headed Wagtail. Motacilla citreola veræ Buturlin. ♂ 7–11–27, ♂ 4–1–28, ♂ 25–3–29.

Winter visitors, arriving about the end of September or beginning of October, but no exact dates recorded, as it is by no means easy to distinguish between this species and the last in the field. This species never appears to occur on large flocks, or away from water, and is chiefly seen on the margins of tanks and ponds. Most of the males are in breeding plumage by the end of March, and leave early in April, but one was seen by Bircha Lake on 11–5–28 which had not completely assumed breeding plumage.

The Tree-Pipit. Anthus trivialis trivialis (Linn.). ♂ 5–12–27, ♂ 27–1–28, ♀ 30–1–28, ♂ 6–2–28.

A very common winter visitor, found in every type of country except swamp and thick jungle. It is very common in gardens. Earliest and latest dates, September 26 and April 13. During the greater part of its stay in the district, it is found in small flocks, but the flocks break up into pairs during the last month before departure.

The Persian Rock-Pipit. Anthus sordidus decaptus Meinertz. ♂ 28–12–28.

The single specimen obtained seems to belong to this race. It is occasionally seen in winter, occurring either singly or in pairs. It frequently perches on the top of haystacks. Open grassland was the only type of country in which it was seen. Very shy and difficult to approach.

Richard's Pipit. Anthus richardi richardi (Vieill.). ♂ 28–11–27.

The above specimen was obtained near Killod, about three miles from Mhow. No other record.

The Indian Pipit. Anthus richardi rufulus (Vieill.). ♀ 29–7–27 ; 0 ? 24–8–27, ♂ 13–2–28 ; ♀ 4–4–28 ; ♀ 11–5–28 ; ♀ 28–12–28.

Numerous and resident, breeding in the rains. Occurs in all types of open country. In the Narbadda Valley, Lt. Young found three much incubated eggs of this species on April 9. (*J.B.N.H.S.*, Vol. XVI, p. 515).

The Eastern Tawny Pipit. Anthus campestris griseus Nicoll. ♂ 14–2–29.

This specimen was obtained about three miles east of Mhow. I have no other record, but Jerdon describes it as 'Abundant at Mhow.' (Jerdon, Vol. II, p. 235).

The Yarkand Short-toed Lark. Calendrella brachydactyla longipennis (Eversm.). ♀ 12–11–28.

The above specimen was obtained from a very large flock on open ground about fourteen miles west of Mhow, and is the only record. The birds were very wild and difficult to approach.

The Red-Winged Bush-Lark. Mirafra erythroptera erythroptera (Jerdon). ♀ 20–8–27 ; ♂ 16–9–27 ; ♀ 23–1–28 ; ♂ ♀ 1–6–28 ; ♂ 16–6–28.

Fairly numerous and resident, keeping to the broken ground in the neighbourhood of the Vindhya Hills. It is mainly a bird of open grassland, but is also met with in fairly open scrub-jungle. Breeds in the rains. Jerdon states that he 'did not find it at Mhow.' (Jerdon, Vol. II, p. 419).

Sykes' Crested Lark. Galerida deva (Sykes). ♂ 8–8–27, ♂ 16–9–27, ♀ 27–3–28, ♂ 26-5-28, ♀ 8-6-28, ♂ 11-6-28. ♂ 31–8–29.

Chiefly, if not entirely, a summer visitor. One Crested Lark was seen in the winter, but I was not certain to which species it belonged. From March to September it is common in open, and often in swampy country. A nest containing two fresh eggs was found in the shelter of two stones in a stubble-field on 10-8-29.

The Indian Rufous-tailed Finch-Lark. Ammomanes phœnicura phœnicura (Franklin). ♂ 23-11-27, ♂ ♀ 27-2-28, ♀ 1-6-28.

Very numerous, sometimes in large flocks and sometimes singly, in winter. About March the numbers are reduced considerably, but some may be seen throughout the year. Of the two specimens obtained on 27-2-28, the male was in full breeding condition, and the ova of the female were beginning to enlarge. Jerdon says of this species:—'I have seen it north of the Narbadda, at Mhow and Saugor, but rare.' (Jerdon, Vol. II, p. 422).

The Pale Ashy-grey Finch-Lark. Pyrrhulauda grisea siccata (Ticehurst.) ♂ 20–2–28, ♀ 3-9-28.

Breeds in March and April on open, dry grassland. During the rest of the year they keep mainly to the same type of country, but are occasionally seen in cultivation in small flocks.

The White-eye. Zosterops palpebrosa (Temm.).

This species is very erratic in its appearances. It occurs at all seasons, but is rarely seen except after rain has fallen. Whether this is only because rain, by bringing out the insects, makes it more lively and therefore more noticeable, or whether there is some local movement, is uncertain. The same phenomenon is noticeable at Peshawar.

The Purple Sunbird. Cinnyris asiatica asiatica (Latham). ♂ 9-7-28.

Common in gardens and scrub-jungle. The majority of the species appear to leave the neighbourhood during the rains, gradually returning during the autumn. The species is notoriously irregular in its plumage-changes, but in this area the majority of the males seem to have adopted their non-breeding plumage by the beginning of August, and to have reassumed their breeding plumage by the end of November. The one specimen obtained was moulting from breeding into non-breeding plumage. Nests containing fresh eggs found between March 3 and June 25. Eggs are incubated for thirteen days. A nest containing two eggs was found on 14-3-29. The eggs hatched, and the young were successfully reared. On May 1, seeing a Sunbird again visiting the same nest, I examined it, and found that it contained one freshly hatched chick. There was no trace of a second chick or egg.

The Thick-billed Flower-Pecker. Piprosoma squalidum squalidum (Burton). ♀ 2-11-28.

This specimen was shot from a party of three or four in scrub-jungle. No other record.

The Indian Pitta. Pitta brachyura (Linn.).

Not observed, but General Betham took its eggs in the valley below Simrole.

The Golden-fronted Pied Woodpecker. Leiopicus mahrattensis (Lath.). ♂ 25-6-28, ♂ ♀ 8-10-28.

All three specimens are intermediate between the northern and southern races. Resident. Found alike in gardens, cultivation, along tree-fringed roads, and in scrub-jungle. A nest found on March 21, in a hole in an acacia, about twelve feet from the ground, contained one hatching egg, one addled, and two infertile. One of the parent birds went off when the operation of cutting into the nest with an adze was begun, but the other did not leave till the excavation was completed and she was being handled.

The Golden-backed Woodpecker. Brachytpternus benghalensis (Linn.).

Resident, in smaller numbers than the last species.

The Black-backed Woodpecker. Chrysocolaptes festivus (Bodd.).

Jerdon states that this species occurs 'in the Vindhyan Mountains near Mhow'. (Jerdon, Vol. I, p. 283.)

The Wryneck. Iynx torquilla (Linn). ♀ 17-3-28, ♂ 30-9-28.

Appears to occur mainly as a passage migrant in spring and autumn, though some may stay through the winter. Earliest and latest dates Sept. 30 and Mar. 17.

The Northern Green Barbet. Thereiceryx zeylanicus caniceps (Franklin).

Occurs in 'the jungles of the Vindhyan range of hills' (Jerdon, Vol. I, p. 311).

The Coppersmith. Xantholæma hæmacephala lutea (Lesson). ♀ 20-2-29.

The above-cited specimen was obtained in rather an unusual way. Seeing two jungle crows pecking at a Coppersmith on the ground I drove them off, and picked up the Coppersmith, apparently little the worse, though unable for the time being to fly. However, in an hour or two it died. The species is resident, and very numerous in the gardens of bungalows. It also occurs, though in smaller numbers, in scrub-jungle and cultivation. The majority of eggs appear to be laid in April, but work on the nest-cavity begins as early as January. During the earlier part of the work of excavation, the birds only work on the warmer days, a cold spell or a shower at once stopping work. Rain at once silences this species, but if there is a break of a few days in the monsoon it recommences calling at once, though not with quite the same energy it shows in the hot weather.

The Common Cuckoo. Cuculus canorus (Linn). ♂ 10-7-28 ; ♂ 30-7-28 ; ♂ 24-6-29.

All three specimens appear to be intermediate between *C. c. canorus* and *C. c. telephonus*, but nearer to the latter than to the former. The status of this species in the neighbourhood of Mhow is somewhat puzzling. It calls vigorously through June and July, chiefly in scrub-jungle in the neighbourhood of the Vindhya Hills, but also to a less extent within the Cantonment itself. I have never heard or seen the species on the plateau north of Mhow. Apart from the two months mentioned, I have only seen it three times, twice in September, and once in November. On each of these three occasions, it was seen just beyond the polo-ground. The *Fauna* (Second edition, Vol. IV, p. 137) says :—' Betham found it breeding in the broken country near Mhow.' General Betham kindly enlarged on this statement in answer to my queries as follows :—' I only twice got an egg of the Cuckoo, both times from the nest of the Black-crested Bunting. One nest was situated on the roadside, where the road had been carved out of the side of the hill, and the other on the ground. These Buntings were very common on the ghat below Simrole.' This did not seem to me quite conclusive, the more so as *Cuculus micropterus* is numerous on ' the ghat below Simrole ' ; so I shot three Cuckoos and examined their organs. The specimens were all calling vigorously when shot, though the first two were in moult, a condition in which birds do not usually breed. Most species of birds are silent when moulting. In both these cases the organs were somewhat enlarged. The third specimen had just mated with a hen when shot, and almost before the body could be picked up the hen was favourably receiving the attentions of another male Cuckoo. This last specimen was in breeding condition. Both in 1928 and 1929 it was a very common sight in the scrub-jungle immediately south of the Mhow-Simrole Road to see Cuckoos engaged in vigorous courtship. They are so numerous in June and July that the fact that they were only observed three times during the rest of the year, and then not in the locality where they were common in the summer, suggests that they are mainly, if not entirely, summer visitors. The three individuals seen in the autumn may well have been migrating from further north. The note of the Cuckoos round Mhow varies slightly from the note of the Cuckoo in England. In both England and Central India the interval between the two parts of the Cuckoo's call varies, but whereas in England it appears to vary normally between a major and a minor third, in the neighbourhood of Mhow it varies between a minor third and a major second. The variation is not merely between individual birds, but may be noted in the call of the same bird. When beginning to call, the Cuckoo generally employs the larger interval, but when it has been calling continuously for some minutes, it appears to get tired and occasionally employs the smaller interval. Some individuals seem to use the smaller interval almost all the time. The following two quotations bear on the subject of Cuckoos in the Mhow area. ' I have seen it at.........Mhow (where very common in the rains, frequenting bushes on grassy plains).' (Jerdon, Vol. I, p. 322). ' Fairly common on the hills near Mhow at the end of the rains.' (S. & B.)

The Indian Cuckoo. Cuculus micropterus (Gould).

Fairly numerous in the Vindhya Hills, calling during June and July. Not recorded at any other season.

The Common Hawk-Cuckoo or Brain-fever-Bird. Hierococcyx varius (Vahl.).

Fairly numerous in summer. It begins to call shortly before the rains break (June), but only comes into full ' song ' after they have broken, and continues to call till well into September. An occasional bird may be heard calling in October. Not noted between October and the end of May, though whether this is due to its migrating or simply to the fact that it is not conspicuous during its silent season, is uncertain.

The Pied Crested Cuckoo. Clamator jacobinus (Bodd.)

A rains visitor, sometimes in considerable numbers. Earliest and latest dates seen : June 21 and Oct. 16. In 1928 this species occurred in very large numbers, in 1927 and 1929 in very much smaller numbers. Few seem to arrive before the beginning of July, or to remain after the end of September.

On 5-8-29 a juvenile was seen in an Acacia being fed by a pair of Large Grey Babblers.

The Koel. Eudynamis scolopaceus (Linn.).

Mainly a summer visitor, but a few stay throughout the winter. Even in winter it seems to be the first bird to wake up in the morning. It begins to call about the middle of March. It victimises both *Corvus coronoides* and *Corvus splendens*.

The Sirkeer Cuckoo. Taccocua leschenaulti sirkee (Gray).

Occasionally seen, chiefly in scrub-jungle. Appears to be resident.

The Coucal or Crow-Pheasant. Centropus sinensis (Stephen).

Numerous and resident. It breeds during the rains, and seldom calls at other times. A break of a few days in the rains silences it. The female has a very peculiar call used in courtship. The following is an extract from my diary for September 5:—'When I first saw them (*i.e.* a pair of Crow-Pheasants), they were both on the ground, the cock pursuing the hen, and the latter running with tail depressed and wings drooped. The male then flew into a tree, while the female remained standing on the ground, drooping and vibrating her wings, and constantly repeating a harsh cry—' Ske-e-e-a-aw'. After about two minutes the cock returned, and the hen, after another short pursuit, allowed herself to be captured, and the two mated, one of them giving voice to a low and melodious variation of the usual 'Whoot-whoot' note.

The Large Indian Paroquet. Psittacula eupatria (Linn.).

Small flock seen on the outskirts of Mhow 3-11-28, and a single bird on the same spot 15-7-29. No other record.

The Rose-ringed Paroquet. Psittacula krameri (Scop.).

Numerous and resident, but moves about locally in relation to food supply. Outside a small temple near Mhow it is the custom of the priest for a few weeks during the rains to put down grain for the paroquets each morning. On these occasions not less than two hundred gather together within a space not more than twenty feet square. No other species of Paroquet was noted feeding there, though it was in the trees just above the temple that the last species was seen. A pair of Jungle Crows occasionally joined the Paroquets at their meal, looking somewhat nervous in the middle of a green carpet of Paroquets. Eggs laid in February and March.

The Blossom-headed Paroquet. Psittacula cyanocephala (Linn.). ♀ 28-5-28.

Resident in small numbers, rarely coming near houses. The one specimen obtained was so young that it cannot have left the nest many days. Eggs are, therefore, probably, laid in April.

The Kashmir Roller. Coracias garrula semenowi (Loud. & Tcshusi). ♀ 22-9-28, ♀ ? 27-9-29.

Numerous on passage about the end of September. Not noted on the spring passage.

The Indian Roller or Blue Jay. Coracias benghalensis (Linn).

Resident. Not as numerous as in most parts of India. Appears to breed in April and again during the rains.

The European Bee-eater. Merops apiaster (Linn).

Several birds which I am convinced belonged to this species, seen at Bircha 24-10-28. Unfortunately, no specimen could be obtained. No other record.

The Common Indian Bee-eater. Merops orientalis (Lath).

Resident in small numbers. Very numerous in autumn and spring. The scarcity of suitable nesting sites probably accounts for the smallness of their numbers in the summer. When courting (about the end of March and beginning of April), the cock frequently presents a wasp to the hen. The increase of numbers in the autumn begins towards the end of September, and lasts till about Christmas. The spring passage is less marked.

The Blue-tailed Bee-eater. Merops superciliosus javanicus (Horsf.). ♂ 19-8-29.

Appears to be entirely a passage migrant, very much more numerous in autumn than in spring. In spring it passes through Mhow in May. In the autumn it makes a longer stay, having been seen from Aug. 2 to Oct. 2.

The Pied Kingfisher. Ceryle rudis (Linn.).

Common over tanks, and occasionally seen fishing on small streams.

The Common Kingfisher. Alcedo atthis (Linn.).

Appears to be resident in small numbers. On more than one occasion when this species ventured to fish in a reach where a pair of White-breasted Kingfishers commonly fish for crabs, the latter attacked the former with great fury and drove him off.

The Stork-billed Kingfisher. Ramphalcyon capensis (Linn.).

One is generally to be seen over the river opposite the Residency grounds at Indore. S. & B. procured one at the Depalpore Lake.

The White-breasted Kingfisher. Halcyon smyrnensis (Linn.).

Numerous and resident, breeding in April. A pair seem to live permanently at the confluence of two small streams just outside Mhow. The streams are generally dry for the last three months before the breaking of the monsoon. So long as there is water in the stream the favourite diet of these Kingfishers seems to be crabs, though they have sometimes been seen to catch fish (*Chilwa*). Their method of dealing with a crab is to beat it to a pulp on a stone or the branch of a tree, and to swallow it whole. Any part that may have fallen off in the beating process, a claw, for example, is carefully retrieved and eaten afterwards. When the stream runs dry they take to a diet of crickets, etc., and in 1928, when water remained in the stream later than it does most years, they gave up fishing at the time they would normally be obliged to. A lady living in Mhow told me that one White-breasted Kingfisher used frequently to come and catch Goldfish from a small pond in her garden.

The Common Grey Hornbill. Lophoceros birostris (Scop.).

Appears to be migratory. Occasionally seen in the winter, frequently in spring and autumn, but only once between April 23 and September 16. It generally occurs in flocks of six. On the one occasion when one was seen in the summer, it was a solitary bird seen on June 10 in the Vindhya Hills just below Simrole.

The Hoopœ. Upupa epops (Linn.).

Resident in small numbers. Breeds in April and May. Its numbers are greatly increased in winter. The breeding birds, from their bright, chestnut colouring and the fact that there is no white between the chestnut of the head and the black of the crest I take to be *U. epops orientalis*. Many of the winter birds are paler in colour, and have a good deal of white in the crest. Unfortunately, no specimens were obtained.

The Alpine Swift. Micropus melba (Linn.).

A passage migrant, fairly numerous over tanks in February and March, and again in September.

The House Swift. Micropus affinis (Gray).

The chief breeding season is in April. Some stay for the winter, and appear to breed then, but the majority seem to leave Mhow about the end of October, returning at the beginning of March.

The Crested Swift. Hemiprocne coronata (Tickell).

General Betham in a letter, referring to Simrole, writes:—'The Crested Swift also hangs out there, but I was never fortunate enough to get eggs.' Lt. Young (*J. B. N. H. S.*, Vol. XVI, p. 514) states that he saw the species in the Narbadda Valley in March and April. I have no record of the species.

Franklin's Nightjar. Caprimulgus monticolus monticolus (Franklin). ♀ 6–8–28.

A summer visitor. They appear to arrive in April and leave about the end of August. The one place where, between those two months, one can always be certain of seeing this species is the channel for taking the overflow water from Bircha Lake. In July and August they occur there in flocks of eight or more. The only other place in the neighbourhood of Mhow where I have seen them is in scrub-jungle south of the Mhow-Simrole Road, where I put one up off two fresh eggs on 1–7–29.

The Common Indian Nightjar, Caprimulgus asiaticus (Lath.). ♂ 16–11–27 ; ♀ 22–6–28.

Fairly numerous in scrub-jungle, and occurs, though in smaller numbers, within the Cantonment. In summer after dark they frequently sit in the middle of the road, where it passes through scrub-jungle, and their large eyes reflect the lights of approaching cars long before their bodies become visible. Eggs laid in the latter half of June.

The Indian Barn-Owl. Tyto alba javanica (Gmel.).

Juvenile bird in captivity, which had been taken from a nest in the roof of occupied barracks some three months earlier, seen 25-12-27.

The only other record of the species is of one which came out of the Bagh Caves, about eighty miles W. S.-W. of Mhow, 23-4-29.

The Dusky Horned Owl. Bubo coromandus coromandus (Lath.).

Occasionally seen.

The Indian Spotted Owlet. Athene brama (Temm.).

Numerous and resident. Breeds in April.

The Osprey. Pandion haliaëtus (Linn.).

One fishing in Bircha Lake, 16-9-27. No other record.

Cinereous Vulture. Ægypius monachus (Linn.).

'I saw it . . . . also at Mhow.' (Jerdon, Vol. I, p. 7.)

The Black Vulture. Sarcogyps calvus (Scop.).

One pair, never more, seen in almost every collection of vultures round a carcass.

The Indian Long-billed Vulture. Gyps indicus (Scop.).

More numerous than the last species, less so than the next.

The Indian White-backed Vulture. Pseudogyps bengalensis (Gmel.).

Resident and very numerous as a rule. All the last three species, however, deserted the district in June 1927, and only came back gradually in the autumn. The time they deserted the neighbourhood of Mhow was the time of heavy and destructive floods in Gujerat and Kathiawar, when there must have been an unusual quantity of food suitable for vultures in those parts. Whether there was any connection, it is impossible to say.

The Neophron or Scavenger Vulture. Neophron percnopterus (Linn.)

Common and Resident. Lt. Young found that in the Narbadda Valley in April there were nests of this species containing eggs on 'almost every suitable piece of cliff'. (*J. B. N. H. S.*, Vol. XVI, p. 515).

The Indian Tawny Eagle. Aquila rapax vindhiana (Frank.).

Resident, but not very numerous. Breeds in March. This species is frequently mobbed by kites.

The White-eyed Buzzard-Eagle. Butastur teesa (Frankl.) 0 ? 5-10-28 ; 0 ? 20-10-29.

Not very numerous, but appears to be resident. Lt. Young found a nest of this species containing one egg in the Narbadda Valley on April 5. (*J.B.N.H.S.*, Vol. XVI, p. 515).

The Pariah Kite. Milvus migrans govinda (Sykes).

Numerous and resident. This species seems to have a strong dislike for the Indian Tawny Eagle, and it is a common sight to see one of the latter being mobbed by kites. Eggs are laid in January and February, but kites may often be seen carrying sticks up into trees about the end of September. As the weather becomes colder, they cease from this practice, and do no more work on their nests till January.

The Black-winged Kite. Elanus cæruleus (Desf.).

S. & B. report having shot one at Mhow on September 25, and two at the Delapore Lake in December and January respectively.

The Pale Harrier. Circus macrourus (S. G. Gmel.).

Fairly numerous in winter. One was seen at Bircha as early as August 2, and again on August 9, but the majority do not appear to arrive before the end of September or the beginning of October.

The Marsh Harrier. Circus æruginosus (Linn.). ♀ 17-9-28.

This is the commonest of the harriers round Mhow, being particularly numerous in September and April. The stomach of the above-cited specimen contained the whole of a lark, apparently *Galerida deva,* with the exception of the head. It is seen in equal numbers over the swampy margins of *jhils*, cultivation, and dry pasture land.

The Indian Shikra. Astur badius dussumieri (Temm.). 0 ? 12-10-27 ; ♂ 15-10-28.

Fairly common, more so in winter than in summer. The former of the above-mentioned specimens contained a snake 4½″ long, a large, striped wasp, a very large beetle, and the remains of several fresh-water crabs.

The Besra Sparrow-Hawk. Accipiter virgatus (Temm.).

S. & B. Obtained two specimens at Mhow in October 1881. They saw no others.

The Shahin Falcon. Falco perigrinus perigrinator (Sund.).

Said by Jerdon to breed 'at the great waterfall at Mhow'. (Jerdon, Vol. I, p. 27). Presumably the waterfall referred to is that at Patalpani, about three miles out of Mhow. A pair of this species were circling round over it when I visited it on March 19, and on the face of the cliff on the side of the gorge opposite the fall, there was a site which had obviously been used for an eyrie for very many years. I did not observe the species elsewhere in the neighbourhood of Mhow. S. & B. state that a pair of this species frequented the same waterfall during the cold season of 1881.

The Lagger Falcon. Falco jugger (Gray).

Occasionally seen.

The Red-headed Merlin or Turumti. Falco chiquera (Dauden).

Occasionally seen, generally in pairs.

The Kestrel. Falco tinnunculus (Linn.). ♀ 24-2-28 ; ♂ 3-10-28 ; ♀ 9-2-29.

A winter visitor in considerable numbers. Earliest and latest dates recorded, September 22 and April 2. Crickets form a large part of their diet and they also seem to be partial to centipedes.

The Common Green Pigeon. Crocopus phœnicopterus (Lath.).

Appears to be resident, but not in very great numbers. More often seen on the outskirts of jungle along the Simrole Road than anywhere else. Lt. Young found their eggs in the Narbadda Valley on March 28 and April 6. (*J. B. N. H. S.*, Vol. XVI, p. 514).

The Blue Rock-Pigeon. Columba livia (Gmel.).

Not as numerous as in many parts of India, possibly owing to the paucity of buildings suitable for nesting-sites. They appear to have no regular breeding season. One or more pairs were engaged in domestic duties in the tower of my church during most of the year.

The Indian Rufous Turtle-Dove. Streptopelia orientalis meena (Sykes).

'Very common at and near Mhow.' (S. and B.) I did not observe the species.

The Spotted Dove. Streptopelia chinensis (Scop.).

Resident, but more numerous in summer than in winter. Early in the rains it gathers into flocks up to about a dozen strong. About November the flocks disappear, and the numbers diminish.

The Brown Turtle-Dove. Streptopelia senegalensis (Linn.).

The commonest dove in the neighbourhood of Mhow. Breeds chiefly from March to May, and again, in smaller numbers, from September to November, i.e., before and after the rains.

The Indian Ring-Dove. Streptopelia decaocto (Frivalszky).

Almost as numerous as the last species. Appears to breed at all seasons. In winter gathers into small flocks.

The Indian Red Turtle-Dove. Œnopopelia tranquebarica tranquebarica (Henry). ♂ 21-9-27.

The least common of the doves about Mhow. It is mainly a summer visitor, only rarely being seen in winter; nest containing one egg found 30-3-29.

The Painted Sandgrouse. Pterocles indicus (Gmel.).

Resident, but more numerous in winter than in summer. On three occasions in July a pair were put up in scrub-jungle. Lt. Young took the eggs of this species on March 28 in the Narbadda Valley. (*J.B.N.H.S.*, Vol. XVI, p. 514). This suggests that the close season, which at present begins in Central India on April 1, might with advantage be put earlier.

The Coronetted Sandgrouse. Pterocles coronatus atratus (Hartert).

'Swinhoe obtained three specimens from Mhow in Dhar.' (*Fauna*, Vol. V., p. 268.)

The Common Sandgrouse. Pterocles exustus (Temm.).

Fairly common, particularly so in April. Jerdon says of this species, 'At Mhow—most of them leave the district after breeding in July and do not return till the end of the rains.' (Jerdon, Vol. II, p. 503).

The Peacock. Pavo cristatus Linn.

Never seen in cultivation, and not very common in jungle, as the species has been shot a great deal in the neighbourhood of Mhow. In 1928 a law was passed by the Indore Durbar making it illegal to shoot this species in Indore State. If this law is enforced, Peacocks may be expected to become very much more common.

The Red Spur-Fowl. Galloperdix spadicea (Gmel.).

'Seen in Vindhya Range.' (Jerdon, Vol. II, p. 542).

The Blue-breasted Quail. Excalfactoria chinensis (Linn.).

One seen about five miles south of Mhow, 8-5-29.

The Common Quail. Coturnix coturnix (Linn.).

Fairly numerous in the winter.

The Rain Quail. Cotuanix coromandelica (Gmel.).

Not so numerous as the last species. Not observed in the summer.

The Jungle Bush-Quail. Perdicula asiatica (Lath.).

Very numerous in scrub-jungle in spring and summer. Less numerous in winter.

The Rock Bush-Quail. Perdicula argoondah (Sykes).

Appears to be resident in small numbers, and sometimes occurs in the same covey with the last species.

The Painted Bush-Quail. Crytoplectron erythrorhynchum (Sykes).

A pair seen near Dunga gaon, about two miles from Mhow, 21-8-28.

The Painted Partridge. Francolinus pictus (Jard. and Selby).

Numerous in long grass, crops, and rushes.

The Grey Partridge. Francolinus pondicerianus (Gmel.).

Not so numerous as the last species, and keeps to drier ground as a rule.

The White-breasted Waterhen. Amaurornis phœnicura (Pennant).

Numerous on the river at Indore. The only other record is of one bird, possibly the same individual each time, which was always to be found by the Ghambier River just beyond the Mhow golf links in March 1928 and 1929.

The Brown Crake. Amaurornis akool (Sykes).

One was found sitting on six eggs in a nest built in a collection of flood-wrack in the top of a stunted Acacia on the bank of the Ghambier River, on Sept. 2. The nest was about four feet above the ground and about ten feet above the surface of the water. The bird sat very close, and used to allow me to watch her from a range of about three feet. This is probably the same bird that I had seen, without being able to identify it, skulking about by the stream at this point on a good many other occasions. The species was not observed elsewhere.

The Moorhen. Gallinula chloropus (Linn.).

Numerous on the river at Indore. Once or twice seen on the Ghambier River.

The Common Coot. Fulica atra atra (Linn.).

Very numerous on some tanks, and entirely absent from others apparently as suitable.

The Sarus. Megalornis antigone (Linn.)

Numerous at all seasons in all types of country except jungle. It is an irregular breeder, but by far the majority of eggs are laid in September.

The Likh or Florican. Sypheotides indica (Gmel.).

Mainly a rains visitor in varying numbers. It was more numerous in 1928 than in 1927 or 1929. Eggs laid in August. 'Common during the rains, at which season it breeds but some of them remain in the neighbourhood of Mhow throughout the year.' (S. and B.)

The Stone-Curlew. Burhinus œdicnemus (Linn.). ♂13-2-28.

Seen occasionally, always on rocky hillside covered with a growth of young 'country teek', except once when several were feeding in swampy ground by the Bircha overflow.

The Indian Courser. Cursorius coromandelicus (Gmel.). ♂ 11-5-28.

Status doubtful. Frequently not seen for weeks together, while at other times it occurs in great numbers. Very large flocks seen near the 13th milestone on the Mhow-Neemuch Road on November 5 and 12, 1928.

The Pheasant-tailed Jacana. Hydrophasianus chirurgus (Scop.).

This species seems to be mainly, if not entirely, a spring and autumn visitor to the immediate neighbourhood of Mhow. It is very numerous on the shores of Bircha Lake during May. On 13-9-29, they were breeding in large numbers on the various tanks at Mandu, some sixty miles away.

The Red-wattled Lapwing. Lobivanellus indicus (Bodd.).

Very numerous and resident. Local name *Tituri*. The majority of eggs appear to be laid in May, but they may also be found in June and July, and probably in other months as well. All the ' nests ' I saw in May, consisted of a depression in the ground, unlined, and fairly near water. A nest found on July 16, 1928, was, however, of a different type, and a description of it also covers several nests found after the breaking of the rains in the following year. It was situated on the top of a grassy mound, about ten yards from a stream, and the eggs reposed on a bed of gravel, evidently brought from the bed of the stream by the birds themselves. As the monsoon had broken about a month before, and rain was to be expected daily while the eggs were incubating, this arrangement seems to have been designed to provide drainage. For a bird that does no more normally than to make a scrape in the ground, to take special measures to meet special weather-circumstances, suggests a fairly high order of intelligence.

The Yellow-wattled Lapwing. Sarciornis malabaricus (Bodd.). ♀ 23-3-28.

Local name *Lauri*. Status uncertain, but it certainly breeds in the neighbourhood. Seen occasionally on barren ground, chiefly in spring and summer.

The Sociable Plover. Chettusia gregaria (Pall.).

' Seen at Mhow.' (Jerdon, Vol. II, p. 645).

The White-tailed Lapwing. Chettusia leucura (Licht.).

A small flock of birds which appeared to me to belong to this species were feeding near the Towers of Silence on the evening of May 26. I watched them for some time through field-glasses from a distance of from 150 to 200 yards. They were very shy, however, and would not allow me to approach within reasonable range to obtain a specimen.

Jerdon's Little Ringed Plover. Charadrius dubius jerdoni (Legge). ♀ (juv.) 16-7-28

Occasionally seen at Bircha in April and the rains. A pair seen there 22-4-27 were behaving as if they had eggs or young. Lt. Young found their eggs in the Narbadda Valley on May 5. (*J.B.N.H.S.*, Vol. XV, p. 514.)

The Black-winged Stilt. Himantopus himantopus (Linn.).

Common in winter, generally in pairs, but sometimes in flocks up to about twenty. Contrary to general belief, these birds are by no means bad eating.

The Common Sandpiper. Tringa hypoleuca (Linn.).

A winter visitor in small numbers.

The Wood-Sandpiper. Tringa glareola (Linn.).

Occasionally seen in winter.

The Green Sandpiper. Tringa ochropus (Linn.). ♂ 26-10-27; ♀ 15-8-28; ♀ (juv. by oviduct) 2-7-29.

A very numerous winter visitor. From September to April at least one is to be seen by every stagnant pool, and several along the margin of every *jhil*. In April they tend to gather into flocks, and their numbers are increased by the addition of birds on passage from further south. The last species sometimes mixes in these flocks. The majority have left by the end of April, but a few individuals, presumably non-breeders stay for the whole summer. By the middle of July their numbers begin to increase. A pair watched on on March 2, were courting. One was displaying and the other apparently inviting his attentions. The former kept up a call quite unlike the usual call of the species, sounding rather like two flints being knocked together.

The Spotted Redshank. Tringa erythropus (Pall.). ♂, Manpur, 20-10-28.

Occasionally seen, always solitary, in winter.

The Redshank. Tringa totanus (Linn.).

A winter visitor in small numbers, occurring singly and in pairs.

The Greenshank. Tringa nebularia (Gunner). ♂ 19-11-28.

A winter visitor in larger numbers than either of the last species, usually seen in pairs.

The Little Stint. Erolia minuta (Leisler).

Occasionally seen in winter, and more frequently in March and April. Earliest date seen, Aug. 3.

Temminck's Stint. Erolia temminckii (Leisler). ♀ 9-5-28 ; ♀ 27-4-29.

More numerous than the last species, especially in April and May. During the winter they occur in small parties of about five, but towards the end of the season in pairs, which may often be seen courting.

Fantail Snipe. Capella gallinago gallinago (Linn.).

Fairly numerous in the winter.

The Pintail Snipe. Capella stenura (Bonaparte).

A winter visitor. I have been told that in the neighbourhood of Mhow the last species is more numerous from September to November, and the present species after November, but I cannot vouch for this personally.

The Painted Snipe. Rostratula benghalensis (Linn.).

Resident and fairly numerous, but subject to local movement as the swamps dry up.

The Black-headed Gull. Larus ridibundus (Linn.).

One seen over a tank about fifteen miles from Mhow, 26-11-28. No other record.

The Indian River Tern. Sterna seena (Sykes).

Fairly common over tanks in winter. Lt. Young saw a young bird of this species near Mhow on May 15. (*J.B.N.H.S.*, Vol. XVI, p. 516).

The Black-bellied Tern. Sterna melanogaster. (Temm.).

Also seen in winter, but less commonly than the last species.

The Indian Shag. Phalacrocorax fuscicollis (Steph.).

Resident in all suitable localities.

The Little Cormorant. Phalacrocorax javanicus (Horsfield).

Appears to be resident, but by no means so common as the last species.

The Indian Darter or Snake-Bird. Anhinga melanogaster (Pennant).

A pair to be seen on almost every tank at all seasons.

The White Ibis. Threskiornis melanocephala (Latham).

One seen by tank fifteen miles west of Mhow, 12-11-28, and one by the Narbadda at Barwani, 24-4-29.

The Spoonbill. Platalea leucorodia (Linn.).

Two or three at Barwani by the Narbadda River, 24-4-29.

The White Stork. Ciconia ciconia Linn.

Two or three by the Narbadda River at Barwani, 24-4-29.

The White-necked Stork. Dissoura episcopa (Bodd.).

Resident in small numbers.

The Black-necked Stork. Xenorynchus asiaticus (Lath.).

Occasionally seen.

The Open-bill. Anastomus oscitans (Bodd.).

Several by the Narbadda at Barwani, 24-4-29.

The Purple Heron. Ardea purpurea (Linn.).

One on island in Jeshwantnagar Lake, 20-8-28.

The Grey Heron. Ardea cinerea (Linn.).

Seen at all seasons, but most numerous in winter.

The Large Egret. Egretta alba (Linn.).

A pair seen over a tank about thirteen miles west of Mhow, 5-11-28. Not identified with certainty on any other occasion.

The Little Egret. Egretta garzetta (Linn.).

Fairly common at all seasons.

The Cattle Egret. Bubulcus ibis. (Linn.).

Occurs at all seasons, but a great increase in numbers takes place the day after the first rain of the monsoon falls. In the immediate neighbourhood of Mhow I have not found any colonies breeding, though in May I have seen them carrying sticks. Two nests in a tree on the platform of Rutlam Railway Station contained two and three fully-fledged young respectively on 3-8-28.

The Reef-Heron. Demiegretta sacra (Gmelin.),

One seen flying high and steadily from the west about 7-30 a.m. on 8-10-29. On coming over the polo-ground it circled down and joined a party of Cattle Egrets which were feeding there. After feeding with them for about five minutes it flew off steadily due east, rising as long as I could see it.

The Pond Heron. Ardeola grayii (Sykes).

Common at all seasons wherever there is water.

The Night-Heron. Nycticorax nycticorax nycticorax (Linn.).

One seen by the Ghambier River, about five miles from Mhow, 23-9-29.

The Common Flamingo. Phœnicopterus ruber (Linn.).

One seen by the Narbadda, near Barwani, 24-4-29.

The Cotton Teal. Nettapus coromandelianus (Blanf. & Oates).

Seen occasionally on Bircha Lake, at Dhar, and Mandu. At the latter place they appeared to be breeding, 13-9-29.

The Bar-headed Goose. Anser indicus (Leatham).

One seen on a tank about thirteen miles west of Mhow, 5-11-28.

The Lesser Whistling Teal. Dendrocygna javanica (Horsf.).

Numerous at Bircha during the early part of the rains. Occasionally seen there and at Jeshwantnagar up to the end of September.

The Ruddy Sheldrake or Brahminy Duck. Casarca ferruginea (Vroeg.).

Not uncommon on the Narbadda in winter. Mr. M. Young reports having seen them there as late as April 14. (*J.B.N.H.S.*, Vol. XIV, p. 515.)

The Mallard. Anas platyrhyncha (Linn.).

A winter visitor in varying numbers. It was more numerous than usual in the winter of 1928-29, which was an abnormally cold winter over the whole of Northern India.

The Gadwall. Chaulelasmus streperus (Linn.).

A very numerous winter visitor.

The Common Teal. Nettion crecca (Linn.).

The most numerous member of the family in winter. Earliest date recorded, Sept. 16.

The Garganey or Blue-winged Teal. Querquedula querquedula (Linn.).

Occurs in winter, but is more numerous in the spring. Latest date seen, May 9.

The Shoveller. Spatula clypeata (Linn.).

Not uncommon in the winter. Mr. M. Young says :—'I saw one flock of seven Shovellers (*Spatula clypeata*) on April 14, and shot one which was quite good eating.' (*J.B.N.H.S.*, Vol. XVI, p. 515.)

The little Grebe or Dabchick. Podiceps ruficollis. (Vroeg.).

Resident in small numbers on permanent water. Never seen on tanks that dry up.

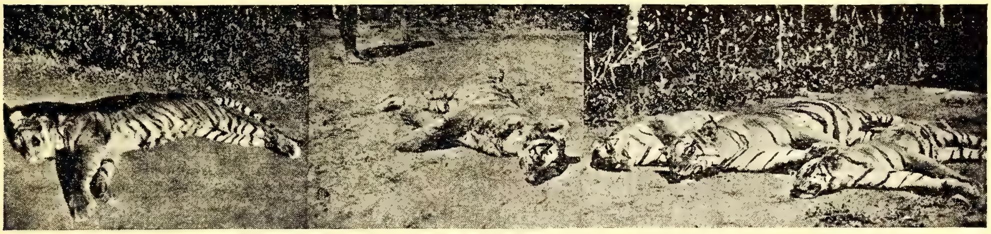
A TALE OF FIVE TIGER

BY

R. C. MORRIS, F.Z.S., F.R.G.S.

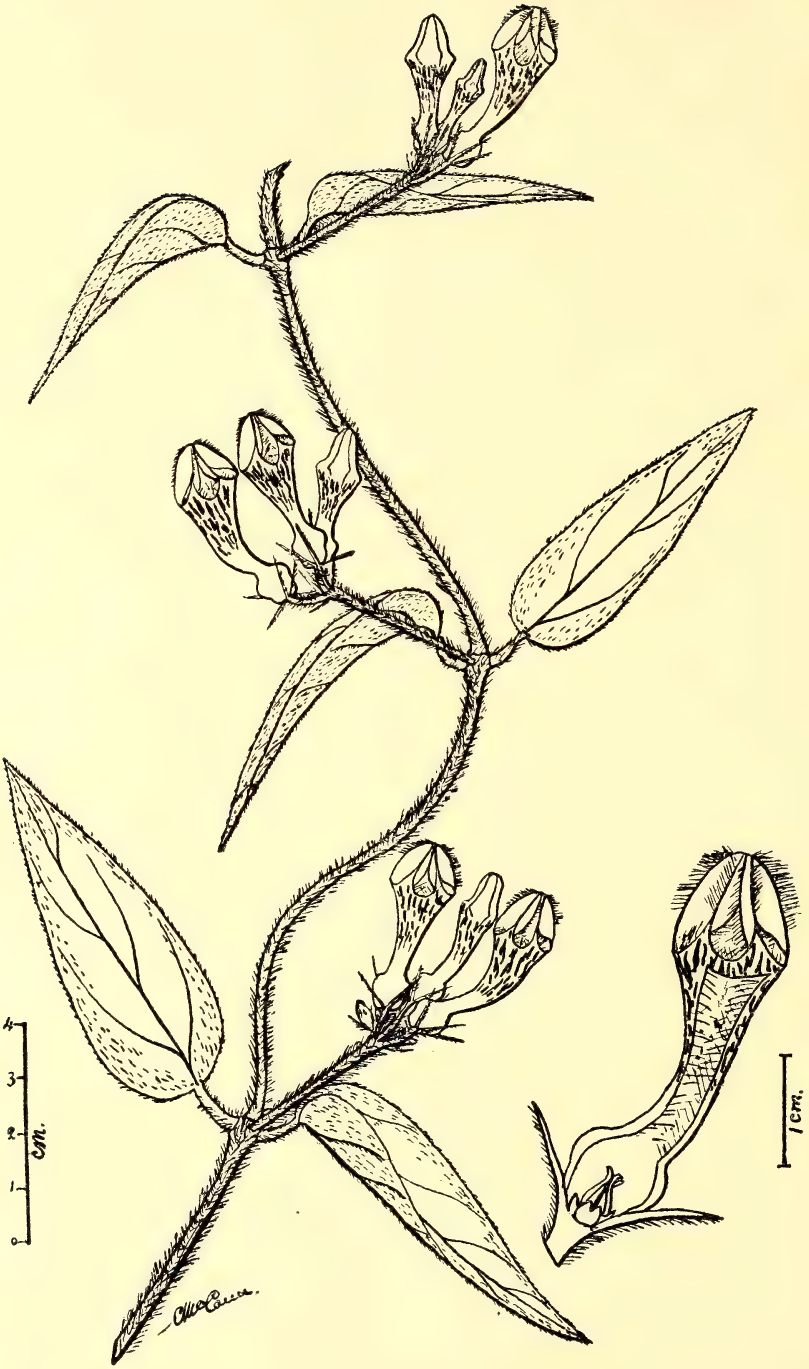
(*With a photo*).

On the 23rd January news came in of a tiger kill some 15 miles away. I was not long in getting away in my Ford van, and was in my machan by 5 p.m. Only a mouthful had been eaten of the kill. The kill was a cow I had tied up on a path running through dense forest, on the borders of a stream, in the hopes of bagging a large tiger that had been prowling around these parts for some time, and calling—the grand "Ar-r-o-ungh"—as he roamed the country side. The kill was almost certainly his. At 6 p.m. monkeys could be heard swearing in the trees someway behind me, and 30 minutes later a low moan from a tiger. At about 7 p.m. an animal galloped passed behind me, crashing heavily through the undergrowth, followed a few seconds later by another. I soon realised that they were tiger and it was not long before the jungle around seemed to be full of tiger, trampling all over the place. At just about 7-30 p.m. I heard more than one tiger approach the kill and start feeding. I turned on my torch (a 2-cell Ever-Ready, clamped to my rifle) and five tiger were revealed grouped round the kill, the largest, a monster, furthest to the right. Before I could fire the big tiger stepped back into the shadows and I took the next in size, a tigress, and rolled her over. The remainder scattered, I switched off the light, and dead silence supervened for about three or four minutes—then I heard a tiger moving on my left, and another on my right, and a few seconds later I heard another move across my front near the kill. I quickly lit up the kill, shot a smaller tigress just before she entered the darkness to the right of the kill (she disappeared as I fired), and switched off again. Once more dead silence, and a little later I heard a tiger on my right walk heavily away, and another on my left walked round (behind my machan) to my right. Then the former, undoubtedly the big tiger, that had walked away, started calling his great, organ-like "Ar-r-o-ungh" sending the notes crashing out into the stillness of the night with a startling suddenness,



The calls, at intervals of about 10 seconds, were kept up from then on till 4-30 a.m., except for two intervals when the tiger returned to the scene of slaughter and licked the large dead tigress, which was lying out of view, to my right. On each occasion he spoke his mind to one of the other two tiger, which I fancy was standing near the dead tigress, and a great rumpus there was too, coughing roars, and giant cat-like spits and snarls—and then away out into the far distance he wandered off again calling, his calls sounding fainter as he went further away and louder again as he came round on his detour. Now and again, as he drew near, he would halt and vary his call to a short ''Ar-r, Ar-r'', and then the deep ''Ar-r-o-ungh''. At about 4-30 a.m. he came to the dead tigress for the third time, now calling, and the air seemed to quiver as the grand volume of sound reverberated through the surrounding jungle. As he reached the tigress, a few paces from the kill, he stopped, and all sound ceased. The sudden cessation of sound was weird in the extreme, there was not a breath of wind, and the very insects in the jungle seemed to participate in maintaining a heavy and oppressive silence. I could distinctly hear the tiger breathing, and the firm tread of one of the other tigers could be heard in the jungle behind me, while some way off the fifth tiger commenced to call plaintively. This silence lasted for about half an hour, the tiger listening intently. I heard no sound to indicate that the tiger had moved from his position, and jumped perceptibly when the kill was suddenly jerked, and this was followed by a great tearing of flesh and sounds typical of the big cat indulging in a hearty meal. I waited for a minute or two and then switched on the light—a huge tiger lay at full length at the tail end of, and at right angles to, the kill. He lifted his great head and stared up at me and next moment was roaring and rolling on the ground mortally wounded. Before I could fire again he disappeared, crashing into the darkness for about 50 yards, and then came deep gurgling sobs, and—silence. I lay back against the back rail of my machan with a feeling of relief and a queer feeling also that I had undergone a certain amount of strain. Dawn brought with it all the usual awakening noises of the jungle, and there was very little to show, sitting where I was in the machan, that anything had happened during the night—the kill was in the same position, very little more had been eaten from it, and no sign of the three tiger I had shot. I was also not sure that the smaller tigress I had fired at was dead. I called to my men who were in some fields not far off—and descended from my machan. As I approached the kill I saw the larger tigress lying dead a few paces down the path the old tiger was wont to travel along. I walked down the path a few yards beyond and I saw the smaller tigress lying dead three or four feet off the path. I returned to the kill and advanced cautiously along the tracks of the old tiger, which had lurched off in the opposite direction, and to my delight, found him lying stone dead about 50 yards away. This was great, and the joy of my shikaries can be realised. A dozen villagers were soon got together and the three tiger were carried to my Ford van, where they were placed side by side—an imposing spectacle! They measured 9 ft. 10 in., 8 ft. 7 in. and 7 ft. 5 in. The shikaries' opinion that the kill was the work of the old tiger, probably at dawn, which would account for his not having eaten more, and that the other four happened to join him by chance, was shared by me.

To continue, I sat up again the following night in the hopes of seeing the two surviving tiger on the kill, but although I heard at least one of them moving about they did not approach the kill. The following night saw me motoring on the road again to sit up for the third time. I had perforce to start very late, and it was dark before I had got half way. When nearing the eventful spot as the car swung round a corner, the headlights showed a tiger advancing up the road. In a moment the tiger had disappeared below the road, and I slowly brought the car to a standstill at the spot where it was seen to disappear. I quickly strapped to my fore-head an electric Inspection Lamp I had in the car, and leaning out over the side I found myself looking into the tiger's eyes at a distance of about ten or twelve feet. I had already loaded my rifle, and slowly bringing it up to my shoulder and aiming between its eyes I fired. The tiger rolled over with a roar, and then rushed off without giving me a chance of putting in a second shot. It was pitch dark, and following up the tiger then was out of the question. I was down on the spot next morning with my trackers and two dogs; and immediately picked up a handful of teeth and bits of bone, which indicated that my bullet had smashed the poor brute's lower jaw. We followed the blood tracks down the hill-side to a ravine and up the further slope. It was soon apparent that the tiger had avoided all thick cover, and made a detour round every bush and thicket. By midday we could find no further blood tracks, and after searching two small nullas we decided to make straight for a large shady stream—a most likely place for a wounded tiger to choose. Sure enough we found fresh tracks on the dry sand; but after following the bed for a short distance the tracks led out of the nulla again, and were lost. It was now late, and nothing further could be done for the day. I was down again early next morning, and very soon fresh tracks were picked up in the nulla. The tracks entered the nulla down a narrow game path leading out of dense *Lantana* and "Sigie" thorn, followed down the bed for some way, and led up into similar thick cover on the other side. Cautiously following up the tracks we emerged into short grass and on the hard ground the tracks were again lost. Returning to the nulla we effaced all traces of tracks on the sand, and I had just decided to sit up over the nulla that night hoping to see the tiger come along when news of a fresh kill nearby was brought to me, a natural one. I immediately visited the scene of the kill, had a machan put up, and shot the fifth of the group, a young tigress, (7′10″) at 7-30 p.m. Next morning fresh tracks were found on the sand in the nulla higher up, but again we could not discover where they led to. For the next three days this was repeated: fresh tracks were to be seen every morning; but the tiger could not be located. He would enter and leave the nulla by one or other of the several game tracks —through the almost impenetrable cover on either side, but it was impossible to tell where he was lying up; and the dogs were not of much help. The use of cattle was out of the question in this type of cover. On the following day, however, our luck changed. I had sat up all night over the nulla with no result as usual, and now wandered up the stream searching for fresh tracks and found them; but this time *moist* tracks on the dry sand: it was evident that the tiger had been down to water only a short while before. The tracks led up one of the paths into the dense cover and the fresh wet pug marks could not be missed. I had advanced up the path for about fifteen yards when a low hiss from my tracker who was about five yards behind me brought me crawling back to his side, and following the direction of his pointing finger, I saw the tiger lying tail on, about four yards off. Taking quick aim at the root of its spine I fired, and immediately the tiger was in its death throes. Its struggles carried it another six or seven feet further into the cover, where it lay almost hidden from view. Advancing on my hands and knees cautiously I put in another shot when I found myself in a position to see the tiger well. The tiger was already dead however, and we hacked our way through the cover to its side. As was to be expected the poor animal was in a terrible condition, the lower jaw had been completely blown away, and the wound and mouth were a mass of maggots. The tongue was intact, so presumably the tiger had been able to drink: but it made me sick to feel that the wretched animal had been in this condition for a week. It was a great relief to get it, and its death brought to a close a most unusual tiger episode—the visit to a kill of five tiger and the bagging of all five eventually. The last tiger was a male, measuring 8′.


4
3
2
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cm.
1 cm.
McCann

Ceropegia hispida, Blatter & McCann, *sp. nov.*

ANOTHER NEW *CEROPEGIA* FROM THE WESTERN GHATS.

BY

E. Blatter, s.j., ph.d., f.l.s., and C. McCann, f.l.s.

(*With a Plate*).

Ceropegia hispida Blatter & McCann, *sp. nov.*

[*Asclepiadacea accedit ad C. elegantem* Wall. *sed differt caule, petiolis, foliis, pedunculo necnon pedicellis dense hispidis vel hirsutis, petiolis fortibus, corollae lobis subobovatis, sepalis subulatis dense hirsutis.*]

Suffruticose. Root tuberous, 3 cm. long. Stem twining, 1·5 m. long, slender, green tinged with black or purple, densely hispid, especially the younger parts. Leaves up to 12 cm. long, 4 cm. broad at base, ovate-lanceolate, acute to acuminate, rounded or subcordate at base, membranous, margins ciliate, upper surface hirsute from slightly bulbous bases, lower surface with scattered hairs and strongly hirsute on the nerves, nerves depressed above, prominent beneath. Petiole 15 mm. long, hirsute, channelled above, a few glands above the petiole on base of leaf. Flowers 1-5 in umbellate cymes. Peduncle arising from between the petioles, 2·5-3 cm. long, purple, densely hispid; pedicels 1 cm. long, densely hispid; bracts subulate, hirsute, 7 mm. long. Calyx 5-partite, divided to the base; sepals subulate, densely hirsute outside, 9 mm. long. Corolla pale green mottled with long vertical purple lines in the upper half below the lobes, 4 cm. long, with a large hemispherical head 12 mm. diam.; tube inflated globose at base, glabrous, curved, enlarged at the mouth, ciliate inside with the exception of the inflated portion; lobes 11 mm. long, subobovate, 10 mm. broad at the widest part, connate almost halfway down, yellow-green with the margins purple, midrib of ventral side ciliate with long purple hairs in the upper half only. Outer corona-lobes shortly horizontally oblong in the basal part, apex deeply bifid, teeth sharply deltoid, with silky hairs outside and inside; inner corona-lobes 4 mm. long without the hook, cylindric, strongly hooked. Fruit not seen.

Locality: Western Ghats: Panchgani, near Godauli (McCann and Fernandez (No. 3566, type).

Flowered 6th Oct., 1930.

SEA-FISHING ON THE BOMBAY COAST

BY

H. C. MUELLER, D.SC.

Public attention has lately been redrawn to the fishing problem of the Western Coast, by the activity of the Bombay Natural History Society. Urgent work is necessary: enormous treasures are to be lifted from the sea to provide a large maritime population with a cheap and valuable food. The sea is abundant with edible fish; the Indian peoples need a cheap and nourishing food; they are to a great extent fish-eaters. To-day's supply of sea fishes in the Bombay Presidency is insufficient, and the preservation of fishes for inland transport is most primitive and inefficient. Everybody —from Government to the fishermen—seems to be anxious to improve matters. In short, the conditions are favourable and the interest sufficient so that with concentrated energy and some skill most satisfying results should be obtainable in a short time.

The Bombay Government have already made a bold step in carrying out trawler-fishing along our coast by the *"William Carrick"*. Admittedly, as yet, no practical result has come out from this experiment; but the information gained by the *"William Carrick"* will be of enormous value when once the fishing industry in the Bombay Presidency is developed, and moreover, the work of the *"William Carrick"* has in my opinion shown the way in which the fishing industry should be developed: not by trawler-fishing which, through its fuel consumption and expenses for a European crew, cannot compete with local fishermen and which in supplying the market from time to time only with quantities of fishes, needs first of all a preservation plant and a specially organised market.

The development should come from and with the local fishermen who are well able to increase their catches and work efficiently if they are taught the right way how to do it.

I have watched the fishermen in Chimbai-Bandra and gone out with them for fishing. Chimbai supplies the Bandra and Bombay market with fresh fishes and dries a certain amount of Bombay Duck, Ribbonfishes (Waghti, *Trichiurus*) and cut Rays for the up-country and foreign trade. I think I can assume that the situation in other parts of the Bombay Presidency Coast is similar to that in Chambai with the exception that greater difficulties for marketing are to be faced.

The bottom of the sea off Bombay Island is a gradually deepening flat, covered with a very soft mud until a distance from shore of about ten sea-miles and a depth of about ten fathoms is reached. Beyond this the bottom of the sea continues to deepen gradually but the mud apparently loses somewhat of its great softness.

After the monsoon each community of the fishing villages in Bombay Island prepares three fishing grounds. The farthest is about eight to ten sea-miles from the coast with a maximum depth of ten fathoms. The nearest ground is in about five fathoms deep and the third lies halfway between the two others. The fishing grounds consist of two anchored buoys for each boat, the buoys all lying in a row at an angle to the tidal currents which flow North to South and South to North, parallel with the coast. The currents are strong and make a good anchoring of the buoys necessary.

This anchoring in the very soft mud is done by inserting long stakes into the mud, sometimes as much as thirty feet deep. The stakes either stick out of the water—in the grounds where the water is shallower—or the iron shoes at the bottom of the poles are left in the mud and the pole itself removed.

There is generally one catch per day by each boat—mostly at night—so that the catch does not suffer from the heat and the sun of the day while bringing it to shore.

The net, consisting of two wings and a bag in the centre is tied to the two stakes at the time of change of tide, just when the current of the water reverses. The net opens through the current and rests at the bottom of the sea. Before the tide changes again, the men commence to pull in the net which takes sometimes one hour and the catch is sailed or rowed home for the market.

The water was rich with plankton in October 1930 and there was a phosphorescence of the sea such as I have never seen elsewhere. We could see the net at a depth of about 9 fathoms as an indistinct silver cloud, the light coming from plankton, thrown against the net and the ropes in great quantities.

There is an absence of any mechanical devices on the fisher-boats. A small winch for instance, made by the village blacksmith would facilitate and quicken the heaving in of the net and of the second buoy before fixing the net and possibly save one hand in each boat.

The fishermen struck me as hard working, robust, cheerful and open minded.

The sailing (or rowing) from the fishing grounds to the villages takes from three to ten hours, on the average about 6 to 8 hours and it often happens that through the delays by western winds or lack of wind in the morning, the fishes suffer before they can be landed.

At times when tides are low, the catch is very poor and many boats do not go out. Apparently, the fishes avoid shallow waters and keep at a certain depth changing the places with the height of water. The fixed fishing grounds prove a great handicap here and more so the inability of the fishermen to establish their fishing grounds in deeper waters. The anchoring stakes are long and heavy and have to be manipulated by hand from between two boats. Longer poles for greater depths are out of question for the fishermen, as long as they do not have heavier boats and mechanical devices at their disposal.

The *"William Carrick"* found that the best fishing grounds for coastal fishery were apparently in 20 to 25 fathoms of water. Our local fishermen seem to touch just the edge of the good fishing grounds. If they were in a position to go farther out and to land their catch quicker, if they could continually fish from their boats and make use of all four of the daily tides, the result would be many times that of to-day's fishing. They could achieve all this if each village had a few boats fitted with motors—not so much for fishing as for the transport of fishes. The anchoring of boats and buoys by means of an ordinary light anchor will be possible for our fishermen if they have motor-driven winches at their disposal for lifting these anchors out of the soft mud.

Crude Oil motors can be fitted to the existing fishermen's boats. The men themselves when they heard of this, were much interested and suggested that they would stay in sea and continue fishing with all tides if a motor-boat would bring them food and water and take the catches home to market regularly.

So much can be done here and it is very satisfying to hear that the Development Department of Messrs. the Burmah Shell Oil Storage and Distribution Co. Ltd. are contemplating the fitting of a fishing boat with a suitable and economic motor to demonstrate its usefulness along the coast. A start made in this direction will probably be the nucleus of a development of our fishing industry to a state which will compare or even excel that of other countries with sea fisheries. The conditions on our coast are, I believe, better than those of other countries: fishes are abundant, the waters with the exception of the four monsoon months are not tricky and free from dangers, the weather constantly fine and the Indian fishermen as hard working and daring as any other fishermen.

If so, by comparatively small efforts, the supply of fishes to the coastal markets can be multiplied. There remains another important task to be taken in hand at once: The markets of bigger towns prefer and require special types of fishes and, at the same time, fully grown fishes; a fish-preserving industry can only use the best fish material; thirdly the catching of immature fishes must be prevented in order to protect regular supplies. Sea-fishing in other countries could only be developed fully after a thorough knowledge of the good fishing grounds and the migration of fishes had been obtained, and this applies the more to fisheries in Western India, as we have—besides the observations of the "*William Carrick*"—no knowledge about the occurrence of fishes beyond the 10-fathom water mark. Unless we know *where* and *when* and in *what depth* the various types of our valuable market fishes are to be found, a fishing industry cannot grow. Only when the scientist can tell the fishermen that at such and such time of the year and at such place and in such depth he will find the big pomfrets or Goal or Karel, etc., can we hope for an increase of the Indian wealth through sea-fishing in our province. The financial results of the work of the "*William Carrick*" were far behind expectations. This is due to the fact that every unorganized fish-market will refuse to take up chance deliveries at decent prices but I am confident that our fish trade will be only too keen to make use of any regular and reliable supplies of fishes which are in demand. Therefore the scientist must begin to work to help the fishermen. A Fishery Institute with its own steamers and with a staff of experts to gain and collect the necessary scientific knowledge would be the preliminary requirement. However, in times of political unrest and a vast economic depression, it is too much to hope that Government will be able to provide sufficient funds for such an Institution.

There is however a way to collect valuable information from the fishermen themselves if everyone interested in the problem and living in a fishing port, along our coast, will help to collect, say every month, information as to where and in what depth and what quantities the fishes are caught, which species are then prevalent in his market and at the same time measure the sizes of the fishes caught. The fishermen are very willing to give such information with a fair accuracy.

The Curator of the Bombay Natural History Society—to whom I owe this suggestion, is willing to give any assistance that may be necessary. I venture therefore to appeal to any layman who is willing to help in this important scheme, to communicate with the Curator and to provide him with regular information of the kind just mentioned. Even occasional information is of value and nobody should be reluctant to forward any observation however important or unimportant he may consider it.

But we have still another difficulty to overcome: the vernacular names of our sea fishes change with almost every district and the information gained from fishermen can naturally only be based on the local vernacular names given by the fishermen.

Here again the Bombay Natural History Society is willing to help. We will have to find out the scientific name to every vernacular name given to market fishes along our coast. For this purpose one specimen of each fish should be taken from the fishermen and the vernacular name written with an ordinary pencil on a strong label which is best tied to the fish's tail. The fish should immediately be put into a solution of 2 per cent Formalin (Formaldehyde).[1] A number of fishes should then be sent in a soldered kerosene tin or an earthenware vessel, etc., to the Society who will classify the fish and inform the sender about its scientific name. This valuable information will provide a basis for a study of the migrations and habits of our edible fishes.

I began to collect the vernacular names of the market fishes in Chimbai-Bandra in October 1930 and am publishing below the first list of vernacular names, which I hope, will be followed by many others also from other places. Unfortunately, I had to leave for Europe just after starting the collection and classification of the Chimbai fishes. Therefore my list is anything but complete—while my note is a sketchy one in all parts. My reason for publishing it is my belief that it is necessary to make some start in this direction and because I trust that this note will induce other members of the Bombay Natural History Society to co-operate in the same direction.

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[1] Formalin can easily be obtained from any druggist and is not expensive. The 40 per cent solution sold in the trade should be mixed with fresh water in a proportion of 1 part Form. to 10 parts fresh water.

List of Fish caught during the Month of October 1930 *in Chimbai-Bandra.*

Scientific Names.	*Mahrathi Names.*
Sciæna sina (Cuv. et Val.).	Goal Doma or Goal.
Otolithus argentius (Cuv. et Val.).	Tela Doma.
Sciænoides pama (Ham. Buch.).	Kala Doma.
Polynemus sextarius (Bl. et Schndr.).	Maya.
Engraulis hamiltonii Gray.	Baderkanti.
Pellona filigera Cuv. et Val.	Dolkanti.
Clupea? atricauda (Bleek.).	Kanat. (Sardine).
Caranx djedaba (Forsk.).	Denkha bagras.
Coilia dussumieri (Cuv. et Val.).	Manla.
Therapon jarbua (Forsk.).	Nakhera.
Sillago sihama (Forsk.).	Murdi.
Trichiurus savala Cuv.	Tunkri waghti.
Caranx auricoronæ Chaudhri.	Patri.
Harpodon nehereus (Les.).	Bombil. (Bombay Duck).
Tetrodon lunaris (Bl. et Schndr.).	Khaen.
Sciæna vogleri (Bleek.).	Tela Doma.
Sciæna semiluctuosa (Cuv. et Val.).	Bombera.
Stromateus cinereus (Bloch.).	Serga or Pamhphlit.
Stromateus cinereus (Bloch.).	Kaula.
Mugil kelaartii Gunth.	Selpa.
Caranx gallus (Linn.).	Tzaan.
Trichiurus haumela (Forsk.).	Pitiorkti or Piti waghti.
	Bala or Balwaghti.
Pteroplatea micrura (Schndr.).	Pakert (s).
Dasybatus zugei (Mull. et Hen.).	Sola.
Cybium commersonii (Lacep.).	Tonri.
Ephippus orbis (Bloch.).	Pimpru.
Hilsa toli (Bloch.).	Bing or Bingla.
Carcharias laticaudus (Mull. et Hen.).	Mushi.
Sciænoides brunneus Day.	Kontvil or Kontla.
Chirocentrus dorab (Forsk.).	Dantal.
Arius macronotacanthus (Bleek.).	Singala or Shingala.
Lacatirus lactarius (Bl. et Schndr.).	Lepti.
Cynoglossus macrolepidotus (Bleek.).	Lepti. (Flat fish).
Polynemus plebeius (Lacep.).	Darvil.
Clupea sp.	Gonas.
Hemirhamphus xanthopterus Cuv. et Val.	Toli.
Hilsa ilisha (Ham. Buuch.).	Palkhati.

THE BUTTERFLIES OF THE SIMLA HILLS.

BY

G. W. V. de Rhe-Philipe, F.E.S.

Part II

(*Continued from page* 183 *of this Volume*).

SATYRIDÆ.

Quite a number of species of this family are to be found within the district, and a few of them are butterflies which are amongst the most common of all seen in these hills. Many of the species are, on the other hand, comparatively rare in so far as individual numbers are concerned; and these, keeping as they do to difficult nullahs and thickly overgrown country, have to be looked for and worked for. Sombre coloured insects for the most part, they do not attract attention; and even when seen, are troublesome to catch amongst the bushes and jungle they affect. It is seldom, therefore, they are well represented in the ordinary collector's ' bag '; and information, other than what one gathers oneself or from the few more serious students of entomology, is hard to come by. I was never able to obtain as much as I could have wished to do, and my notes of some of the species are therefore somewhat scrappy. Still the family is interesting enough and merits more attention than it gets.

*50. **Mycalesis francisca sanatana.** Moore.

(Bing. 51; deN. 89; Ev. D2 (5)).

Recorded ' Kulu to Burma ', but extremely rare in these western hills, though more common eastwards. I have not taken it anywhere nearer than Mussoorie, nor seen any actually taken in the district. It flies both summer and autumn elsewhere.

51. **Mycalesis perseus typhlus.** Fruhstorfer.

Mycalesis perseus blasius. Fabricius.

(Bing. 53; deN. 96, 99; Ev. D2 (9)).

These have hitherto been considered as the dry and wet season forms of the same species, but Evans has now treated them as slightly differentiated races, *typhlus* being relegated to the continental plains, and *blasius* to the Himalayas and Burma. Both appear within our limits—fairly commonly in the lower hills and valleys, much more rarely at altitudes above 3,000 ft. Can be taken throughout the year except in tbe very cold months.

52. **Mycalesis mineus mineus.** Linnæus.

(Bing. 54; deN 97; Ev. D2 (10)).

Fairly common in suitable country at the lower altitudes, April to November.

53. **Mycalesis visala visala.** Moore.

(Bing. 57; deN. 99; Ev. D2 (12)).

Evans has restricted the westerly range of this species to Kumaon, but I found it fairly common in the Mussoorie Dun and I once took a battered specimen in the jungle country below Kalka. Will only be found at the foot of the hills.

54. **Mycalesis lepcha lepcha.** Moore.

(Bing. 64 ; deN. 111 ; Ev. D2 (30)).

Rather scarce in the district which is at the westerly limit of its range, but common further east from Garhwal to Kumaon. Most likely to be found in the spring and early summer at elevations up to 5,000 ft. in the jungle terrain affected by all *Mycalesis*, but appears sporadically at other seasons and in the inner hills.

55. **Lethe sidonis vaivarta.** Doherty.

(Bing. 88 ; deN. 149 ; Ev. D3 (7)).

I found this species very common in Dalhousie one October and it is plentiful in the autumn months in the Mussoorie and Kumaon Hills, but, though I have taken occasional specimens in Simla, it never, for some reason, seems to be common in this district. Is almost wholly an autumn butterfly and is not, as far as I know, found below 6,000 or 7,000 ft. Prefers deep forest.

56. **Lethe maitrya.** deNiceville.

(Bing. 92 ; deN. 150 ; Ev. D3 (8)).

Essentially a species of the higher and inner ranges. The late Col. Chaldecott found it fairly plentiful near the Jalauri Pass in September, and I have a specimen from the Narkanda forests taken in October. Would seem to be a post-monsoon insect.

*57. **Lethe nicetas.** Hewitson.

(Bing. 91 ; deN. 151 ; Ev. D3 (13)).

Recorded from the Himalayas from Kulu eastwards, but is rare everywhere towards the western limits of its range. It will be confined to the inner hills. I have not seen it in the Simla area.

58. **Lethe jalaurida jalaurida.** deNiceville.

(Bing. 111 ; deN. 158; Ev. D3 (17)).

This species was discovered by deNiceville near the Jalauri Pass into Kulu, and it is not rare there just before and during the monsoon months. It keeps to the inner ranges and will probably be found in forest country on Huttoo, the Chor and other lofty mountains.

*59. **Lethe goalpara narkanda.** Fruhstorfer.

(Bing. 116 ; deN. 156 ; Ev. D3 (20)).

I have not seen this. It is said to be very local, and, like others of this group, is confined to the higher hills. Some lucky collector should find one of its haunts in the forests beyond Narkanda.

60. **Lethe rohria dyrta.** Felder

(Bing. 79 ; deN. 139 ; Ev. D3 (24)).

The most common species of the genus in the district. May be picked up in almost any well-wooded locality between 6,000 ft. and 9,000 ft. between May and October.

61. **Lethe confusa confusa.** Aurivillius.

(Bing. 82 ; Ev. D3 (27)).

Fairly common here and becomes more so as one goes east. Like other *Lethes*, prefers wooded country. Flies from spring to autumn, but is scarcer after the rains.

62. **Lethe verma verma.** Kollar.

(Bing. 85 ; deN. 146 ; Ev. D3 (28)).

Nearly as abundant as *rohria dyrta* and in similar localities between June and September.

63. **Lethe insana insana.** Kollar.

(Bing. 81 ; deN. 142 ; Ev. D3 (31)).

Not very common, but may, occasionally, be found in forest country from 6,000 to 8,000 ft. from June to October. All my Simla specimens were caught on the northern face of the Mashobra-Mahasu ridge.

*64. **Lethe pulaha pulaha.** Moore.

(Bing. 120 ; deN. 142 ; Ev. D3 (47)).

Ranges from Chamba to Sikkim, but is apparently very rare everywhere west of Kumaon, for I have never come across it or seen it in any of the collections from the Western Himalayas. Is probably confined to the inner hills.

*65. **Lethe yama yama.** Moore.

(Bing. 122 ; deN. 162 ; Ev. D3 (52))

I found this species fairly common in June in Naini Tal, but have not come across it further west. It is recorded from Kulu and will undoubtedly be found in the intervening country. From my experience of its habits in other places, I would expect it to be on the wing for a few weeks only before the rains.

*66. **Orinoma damaris.** Gray.

(Bing. 125 ; deN. 168 : Ev. D5).

Recorded from Kangra to Upper Burma, but is local and rare everywhere. I have never taken it anywhere.

67. **Pararge (= Satyrus) schakra.** Kollar.

(Bing. 129 ; deN. 172 ; Ev. D4 (2)).

This little chap, who rather reminds one of the ' Wall Brown ' in England, is one of the most common of the Simla butterflies. It flutters about the road sides and over every patch of stony ground almost throughout the year.

Pararge mœrula. Felder.

(Bing. 130 ; deN. 173 ; Ev. D4 (3)).

This butterfly really belongs to the extreme north-west, though it has been reported as extending to Kumaon. I have some doubts whether it will be taken in the Simla area ; but I include it as there is a chance that it may wander into the interior boundaries. It is rare everywhere.

68. **Pararge (= Rhaphicera) moorei.** Butler.

(Bing. 127 ; deN. 170 ; Ev. D4 (6)).

Not uncommon, but somewhat irregular in appearance and very local in its haunts. I could not discover it in the Simla District for years : and then, one summer between May and September, I got several in two particular glades of the forests in Mashobra and Mahasu. It was also taken in fair numbers by a collector on the road to Kulu below the Jalauri Pass.

*69. **Maniola pulchra.** Felder.

(Bing. 143 ; deN. 198 ; Ev. D (7)).

Not rare in Kashmir and Pangi, and is found in Kulu and eastwards along the inner ranges as far as Kumaon. I have not seen it from the Simla area, but it should occur in the summer months in the high country of the interior.

*70. **Maniola lupinus cheena.** Moore.

(Bing. 143 ; deN. 194 ; Ev. D7 (5)).

*71. **Maniola davendra davendra.** Moore.

(Bing. 139 ; deN. 191 : Ev. D7 (8)).

The remarks on the previous species apply equally to these two. I have not seen either from within the district myself, but I was told by a P. W. D. road Engineer that a *Maniola*, probably *cheena*, is to be seen on the Himalaya-Tibet road towards Chini.

72. **Nytha parisatis parsis.** LeCerf.

(Bing. 138 ; deN. 176 ; Ev. D8 (1)).

This species is not uncommon, but it needs to be looked for in suitable places and at the right season. Though an occasional specimen may be picked up in the autumn, the real time is the few weeks just before the monsoon begins. It keeps to rocky nullahs and slopes and, while it seldom flies fast or far, it settles quickly and unobtrusively, so that its course has to be closely watched.

Nytha mniszechii baldiva. Moore.

(Bing. 134 ; deN. 180 ; Ev. D8 (4)).

An inhabitant of the inner and higher ranges which may possibly be found along the upper reaches of the Sutlej towards Chini.

73. **Aulocera brahminus brahminus.** Blanchard.

(Bing. 148 ; deN. 189 ; Ev. D11 (1)).

Has been taken in Kulu and I have one from the Sutlej valley above Rampore caught in August. It should occur nearer Simla ; but it is rare or may possibly be overlooked in the crowds of other species of the genus.

74. **Aulocera padma padma.** Kollar.

(Bing. 150 ; deN. 187 ; Ev. D11 (2)).

75. **Aulocera swaha swaha.** Kollar.

(Bing. 149 ; deN. 188 ; Ev. D11 (3)).

These two species are such a common feature of the Simla fauna and are superficially so alike that a casual observer would easily look on them as the same, that they might well be dealt with together. Who has not noticed the heavy looking butterflies, black with a white band across the wings, which fly about and settle on the slopes by the road sides and on the very road itself, and then lean over till the wings almost rest on the soil ? Of the two, *padma* is distinctly the larger and darker and, in Simla, seems to appear a trifle later in the season. It is, except locally, not quite so abundant as *swaha*. The latter generally comes into prominence in May, and after that is seen everywhere from 5,000 to 10,000 ft. Both are on the wing till late autumn, but those seen after September are usually worn and faded.

76. **Aulocera saraswati.** Kollar.

(Bing. 151 ; deN. 190 ; Ev. D11 (4)).

Has the genus general pattern and colouring, and is rather liable to be overlooked in the crowds of *swaha* ; but the beautiful brown striations on the undersides of the wings are distinctive. May occasionally be found anywhere from July to September, but has a tendency to concentrate in certain localities and in these is almost as common as the two preceding. One of these favoured spots was between the 4th and 5th milestones on the road to Mahasu, where the flowers of a thistle and of some other compositæ attracted scores. Another gathering ground was a length of the lower road on Elysium Hill.

77. **Erebia shallada.** Lang.

(Bing. 178 ; deN. 233 ; Ev. D13 (3)).

78. **Erebia nirmala nirmala.** Moore.

(Bing. 180 ; deN. 239 ; Ev. D 13 (4)).

79. **Erebia scanda.** Kollar.

(Bing. 182 ; deN. 235 ; Ev. D 13 (5)).

80. **Erebia hybrida.** Butler.

(Bing. 181 ; deN. 238 ; Ev. D 13 (6)).

81. **Erebia annada cæca.** Watkins.

(Bing. 181 ; deN. 237 ; Ev. D 13 (7)).

*82. **Erebia hyagriva.** Moore.

(Bing. 179 ; deN. (as *Ypthima*) 179 ; Ev. D 13 (8)).

The habits, localities and seasons of these six *Erebias*, lumped by the Simla schoolboy under one comprehensive and very appropriate name of ' hoppers', are so much alike that they can conveniently be grouped for notice. All are insects which favour wooded, shady localities where it is comparatively damp; all appear in the summer months and continue to fly till the autumn but, speaking generally, are most abundant during and for a short period after the rains ; all have the same general habits of flight and settling. Not only are their ways and seasons alike, but they are very similar in appearance on the wing and it is only experience which can then differentiate between them and often a close examination and comparison with detailed descriptions has to be made before individuals can be satisfactorily placed.

Of the species found in and near Simla, *nirmala* is the only one that can be called really common. It is the smallest and darkest of the group and appears in great abundance in June and July, fluttering about the shady roads and hillsides. *Scanda* and *annada* are probably the next in numbers and are larger, lighter coloured (mainly because of the white irrorations on the undersides) insects and are rather more frequently taken towards the end of or just after the rains. *Hybrida* and *shallada* are somewhat uncommon, while *hyagriva* is distinctly rare.

To get a good series of all the species, it is advisable to capture every Erebia that is not clearly a *nirmala* and examine it before release ; and any you are not then certain about should be retained for closer examination and comparison at home with recorded descriptions.

83. **Ypthima nareda nareda.** Kollar.

(Bing. 163 ; deN. 209 ; Ev. D 14 (4)).

The Ypthimas, or ' Ringlets', are small, inconspicuous butterflies which usually lurk in undergrowth and bushes and are not often seen abroad ; but if point is made of looking for them, *nareda* will be found to be not uncommon. It does not seem to go below 5,000 ft. or above 8,000 ft. and may be picked up any time between May and October.

84. **Ypthima asterope mahratta.** Moore.

(Bing. 173 ; deN. 213 ; Ev. D14 (6)).

More a plains species than one of the hills. Is not uncommon in the country round Kalka and probably extends up the valleys.

85. **Ypthima hubneri kasmira.** Moore.

(Bing. 170 ; deN. 217 ; Ev. D 14 (10)).

Also a butterfly of the plains and lower hills and to be found, though not very commonly, around Kalka. I have as yet nowhere found it above 3,000 ft. and I do not think it goes any distance into the hills.

*86. **Ypthima avanta avanta.** Moore.

(Bing. 167 ; deN. 207 ; Ev. D14 (12)).

Said to be found throughout the Himalayas and to be common in Kulu. I have not seen it anywhere west of Kumaon, where it is, at low elevations, a spring butterfly.

87. **Ypthima baldus baldus.** Fabricius.

(Bing. 154 ; deN. 204 ; Ev. D14 (14)).

Very common in the Central and Eastern Himalayas up to about 4,000 ft., but is apparently much scarcer towards the western limits of its range. Should be looked for in the lower hills and valleys from May to October.

*88. **Ypthima indecora.** Moore.

(Bing. 153 ; deN. 206 ; Ev. D14 (15)).

Recorded from Kashmir to Kumaon, but I have not taken it within the district or anywhere near. It is common enough elsewhere.

89. **Ypthima sakra nikœa.** Moore.

(Bing. 161 ; deN. 226 ; Ev. D14 (20)).

This is, by far, the most common of the genus in the Western Himalayas. It occurs everywhere in suitable country from 4,000 up to 9,000 ft. from May to October.

Orsotriœna medus medus. Fabricius.

(Bing. 72 ; deN. 92 ; Ev. D16).

A species of the plains. It has been recorded from Ambala, just outside the district, and it is quite probable that an occasional specimen may find its way into the country round Kalka.

90. **Melanitis leda ismene.** Cramer.

(Bing. 191 ; deN. 243, 244, 249 ; Ev. D22 (1)).

A common butterfly of the plains. I have noticed it at Kalka and have seen specimens in a soldier's collection made round Sabathu ; but it does not, as far as I am aware, extend far into the hills. May be ' flushed ' in scrub jungle at any time but flies freely, especially round the trunks of trees, in the evening. This habit and the dead leaf appearance of the undersides of the wings have led to its being called the ' Evening Leaf '.

Elymnias hypermnestra undularis. Drury.

(Bing. 202 ; deN. 256 ; Ev. D25 (1)).

Has not yet actually been found so far to the west, but it is not uncommon in the Mussoorie Dun and it is possible that one or two may turn up in the damp river valleys at the foot of the hills.

(NYMPHALIDÆ)

We come now to a family of butterflies which, in India, has probably received more attention from the general collector than any other. It is easy to see why this should be the case. Some of the species of which it is comprised are an outstanding feature of the insect fauna of every place ; and being showy and as a general rule, common, they usually attract attention. They present such a diversity of form and size, of pattern and colouring that they arouse interest; and, with the interest, the idea of ' making a collection ' is often born. The Simla Hills are fairly well provided with members of the family ; and though there are, of course, several which are distinct rarities, a goodly proportion of the species are numerous in individuals, and soon become the backbone of every collection that is put together.

The habits of the *Nymphalidæ* are almost as varied as their colouring ; but, though a few of the species display a preference for damp and shady surroundings, they may, as a group, be said to be sunloving insects who delight to flaunt their charms among the flowers of the gardens and meadows and around their favourite shrubs and trees. Open sunny nullahs with forest growth around and clearings and gaps in the woods attract many ; while some species have a marked predilection for the plateaus and downs on the very tops of hills.

And now to continue our list.

91. **Charaxes fabius fabius.** Fabricius.

(Bing. 244 ; deN. 570 ; Ev. F1 (7)).

Has been recorded from Chamba and Mandi and appears generally along the foot of the hills and the Gangetic Plain, getting more common towards its easterly range. Will occur, though rather rarely, in the Kalka area and up the valleys, but not likely to go above 5,000 ft. Flies spring and autumn.

92. **Eribœa athamas athamas.** Drury.

(Bing. 245 ; deN. 568 ; Ev. F2 (2)).

A very strong flying insect like all the others of the group and appropriately named the 'four tail' by school boys. Not rare and may be taken fairly frequently from spring to autumn. The most likely haunts are rocky nullah beds where it flashes from tree to rock, frequently settling on patches of damp sand. Sometimes flits round some favoured tree ; while exuding sap and ordure of any sort is always a strong attraction.

93. **Eribœa dolon dolon.** Westwood.

(Bing 251 ; deN. 565 ; Ev. F2 (7)).

A distinctly rare member of the genus and especially so in the Western Himalayas. Anyone getting a specimen can deem himself fortunate. Very strong and rapid on the wing and difficult to catch unless absorbed in sap drinking. I have not actually taken it in the Simla District, but I picked up a wing one June on a path on the Retreat hill. A summer butterfly in the Kumaon Hills and presumably the same here.

94. **Dilipa morgiana.** Westwood.

(Bing. 262 ; deN. 328 ; Ev. F5).

A beautiful insect and always a prize because of its rarity throughout its range. I could not find it in Simla for years ; and then, one June, I had the fortune to hit on a small colony of males flying round a brown oak tree on the top of Kufri Hill. I picked up another male later near a water trough on the road to Mashobra. deNiceville took some males on the top of Tara Devi. Isolated trees on hill tops are, in my experience, the most likely places for males. Females are very rare indeed and seem to skulk in the valleys. I know of only one taken within our area. This was on the road to Sipi village, also in June. It also flies in the autumn.

95. **Apatura ambica ambica.** Kollar.

(Bing. 255 ; deN. (as *Namouna*) 329 ; Ev. F7 (5)).

The Indian 'Purple Emperor' is not at all uncommon in the Central and Eastern Himalayas, but is rarer in the North West. Flies round trees, but is much more likely to be caught in rocky nullahs with running water. Females are very much rarer. Found summer and autumn but the former is the better season.

96. **Sephisa dichroa.** Kollar.

(Bing. 270 ; deN. 327 ; Ev. F 9 (1)).

The 'Silkie' of the Simla school boy is a feature of open oak woods in May and June. One may often see a dozen or more flitting round a tree or coming down to drink at damp patches by the road side. There is a less prolific autumn brood.

97. **Parhestina persimilis zella.** Butler.

(Bing. 266 ; deN. 337 ; Ev. F 11 (1)).

Never common, but a regular worker will usually pick up a few each season. Nullahs and open woods in the summer will be the most promising localities.

*98. **Parhestina nicevillei.** Moore.

(Bing. 267 ; deN. (as *Zella*) 338 ; Ev. F 11 (2)).

This rare species really belongs to a zone further west round Dalhousie and Chamba. It is said to extend to the Mussoorie hills. I have never seen a specimen from our district.

*99. **Calinaga buddha buddha.** Moore.

(Bing. 451 ; deN. 435 ; Ev. F 14).

Very rare and I have never had the luck to get one. Most of those recorded were from Kulu. Like the Papilio, *Chilasa agestor govindra* which it very superficially resembles, it is a butterfly of the very early spring months, though odd specimens sometimes carry on till June and July.

*100. **Dichorragia nesimachus.** Boisduval.

(Bing. 274 ; deN. 434 ; Ev. F16).

Though the recorded range of this species is ' from Kulu to Burma ', I have some doubts of its right to be included among the Simla District fauna. It is really an Eastern Himalayan butterfly, which, as Hannyngton reports in his paper on the ' Butterflies of Kumaon ', is very rare even on the eastern borders of that district. If found in the Simla Hills, it will be in the low river valleys.

* 101. **Stibochiana nicea nicea.** Gray.

(Bing. 275 ; deN. 418 ; Ev. F 17).

Also more a butterfly of the Indo-Malayan fauna, but it is common as far west as Kumaon at any rate. There are specific records from the Kulu Valley and from the Sutlej near Kotgarh : but it is rare so far to the west. Will occur in the river valleys up to about 4,000 ft.

102. **Euthalia garuda anagama.** Fruhstorfer.

(Bing. 302 ; deN. 513 ; Ev. F 18 (14)).

The North Western race of the species is not uncommon though it does not often figure in collections from these parts. I have seen it near Kalka. The larva feeds on the mango tree, and the imago will almost certainly be found wherever the mango grows. It flies almost throughout the year.

103. **Euthalia lubentina indica.** Fruhstorfer.

(Bing. 296 ; deN. 517 ; Ev. F 18(17)).

Somewhat rare within our limits but will be picked up occasionally anywhere up to 8,000 ft. in the summer or autumn. I have taken it at Kufri ; but the low warm valleys would be more profitable hunting grounds.

104. **Dophla patala patala.** Kollar.

(Bing. 286 ; deN. 490 ; Ev. F18 (25)).

Not often seen at large, but is not uncommon in the localities it favours. It affects oak woods and may sometimes be seen round these trees on Jakko ; but nullahs with oak growth around are its special haunts. It was very common in some ravines behind the Mahasu ridge one year. Appears just before the rains and flies till August or September. Excluding sap or rotting fruit will always attract it if it is in the neighbourhood.

105. **Liminitis danava.** Moore.

(Bing. 318 ; deN. 446 ; Ev. F24 (2)).

Rare throughout its range, and specially so here at its western boundary. I remember that, very many years ago, the catching of a ' Rainbow Tapsel,' as the female was called, was a notable event among the Simla schoolboys. I have taken a female in the stream below Annandale ; and I once came across quite a small colony of males in a secluded corner of the Glen. This corner was also, it so happened, a rendezvous of the common rock-snake, and there were several of these reptiles slithering about the damp rocks. They are harmless, of course ; but—well, I confess that if there is anything I have always loathed, it is a snake of any kind ! I caught one or two of the *danavas* which were well away from the cluster of snakes and then decided to do my shikaring elsewhere. I have only come across the butterfly, both here and in the Kumaon and Mussoorie Hills, in October, so it is presumably a post monsoon species.

Liminitis procris procris. Cramer.

(Bing. 310 ; deN. 452 ; Ev. F 24 (7)).

Not as yet recorded from within our limits, but it is not uncommon in the West Central Himalayas and in the Mussoorie Dun. I have seen it in the Jumna Valley between Mussoorie and Chakrata, and as this is less than fifty miles from our area, there is every possibility of its turning up in the low valleys round Kalka.

106. **Liminitis trivena trivena.** Moore.

(Bing. 315 ; deN. 451 ; Ev. F24 (8)).

A very worn female taken one September near Kufri was, for several years, the only specimen I found. But the species is common enough if only one hits on the right places and season. It is on the wing for only a very short period in May and early June, and then keeps to certain localities. I discovered this when I first made a timely expedition to the nullahs behind the Mahasu-Mashobra ridge, in some of which it could be taken, literally, by hundreds. I have since also found it occasionally in the Water-works area on the nearer side of this ridge and, once, in the Summer Hill nullah. To get really good specimens one must take them within almost a single particular week, as they soon get worn and scrubby. The one I had previously taken in September was probably an unusually hardy survivor of the June brood.

Pantoporia selenephora selenephora. Kollar.

(Bing. 326 ; deN. 467 ; Ev. F25 (4)).

The Simla District is on the borders of the known westerly range of this species, and it has hitherto not been definitely reported from nearer than Mussoorie. I know, however, of one which was caught in the vicinity of Paternala on the Chor ridge, and it may yet be found within our limits.

107. **Pantoporia opalina opalina.** Kollar.

(Bing. 328 ; deN. 462 ; Ev. F25 (8)).

Exceedingly common from spring to autumn. May be seen pretty nearly everywhere sailing about the trees. Does not appear to descend below 4,000 ft.

* 108. **Pantoporia asura asura.** Moore.

(Bing. 333 ; deN. 455 ; Ev. F25 (13)).

Has been recorded from Kulu and from Kotgarh and ranges eastwards as far as Tenasserim. A rare butterfly everywhere and particularly so in the west. I have seen none taken within the Simla Hills.

109. **Pantoporia perius.** Linnæus.

(Bing. 331 ; deN. 454 ; Ev. F25 (14)).

A common Indian butterfly, but here again, Simla is the westerly limit of its range and it is by no means plentiful in the district. Col. Evans took one at San Damiano in June ; and I got one at the same season in scrub oak forest on the spur beyond Elysium Hill.

110. **Neptis mahendra.** Moore.

(Bing. 341 ; deN. 399 ; Ev. F20 (5)).

Not so ubiquitous as the next, but quite common spring to autumn.

111. **Neptis hylas astola.** Moore.
(Bing. 336; deN. 386; Ev. F26 (6)).

Neptis hylas varmona. Moore.

(Bing. 336; deN. 279, 385; Ev. F26 (6)).

The common 'sailer' which is to be seen everywhere right through the spring, summer and autumn. The *varmona* form is that found in the plains and low country, while *astola* is confined to the higher hills. Typical specimens of each of the two are easily distinguished, but individuals of an intermediate type may be found in the demarcating zone.

112. **Neptis yerburyii yerburyii.** Butler.

(Bing. 342 ; deN. (as *Nandina*) 397 ; Ev. F26 (9)).

Very similar in general appearance to *mahendra*, and likely to be mistaken for it especially as both species fly at the same time. *Yerburyii* is much the less common of the two, so it is just as well to take a good look at all the apparent *mahendras* before setting them free as 'not wanted.'

113. **Neptis sankara sankara.** Kollar.

(Bing. 344 ; deN. 466 ; Ev. F26 (10)).

Would be considered rare—till you discover its own particular domain. When such a spot is found, you can usually get all you need. The San Damiano nullah behind the Retreat Hill was generally a good place, but I have also taken it in the Catchment area and in the Summer Hill ravine. Is plentiful only in May and June and it disappears almost completely once the monsoon breaks.

114. **Neptis narayana narayana.** Moore.

(Bing. 346 ; deN. 367 ; Ev. F26 (23)).

Appears at much the same seasons and in the same places as the last, but is always very much rarer. It is necessary, in order to get really good series of these two species, to find one of their special haunts at just the right fortnight or three weeks of the season.

115. **Neptis ananta ananta.** Moore.

(Bing. 354 ; deN. 363 ; Ev. F26 (15)).

This is the only tawny yellow 'sailer' found in the North-West Himalayas and is distinctly rare at this end of its range. I have not taken it myself in the Simla Hills, but I have seen one caught on the Chail ridge. Wooded nullahs and damp clearings in forest are, judging by my experience elsewhere, the most likely spots for them.

* 116. **Neptis zaida.** Doubleday.

(Bing. 348 ; deN. 365 ; Ev. F26 (25)).

A rare butterfly which I was never fortunate enough to get. I believe it prefers low elevations and flies only in the early summer.

117. **Cyrestis thyodamus ganescha.** Kollar.

(Bing. 364 ; deN. 544 ; Ev. F27 (4)).

The familiar 'Map butterfly' known, I expect, to every one who has taken any interest in Himalayan butterflies. Common from spring to autumn, and may frequently be seen floating gracefully around trees. They love the neighbourhood of watercourses and often settle on damp sand and rocks with outstretched wings.

118. **Pseudergolis wedah.** Kollar.

(Bing. 450 ; deN. 417 ; Ev. F29).

Might appropriately be called the 'Brown Map', for the black lines across the wings do suggest a map. Not uncommon but keeps to wet nullahs and damp shady glens. Flies spring to autumn.

119. **Hypolimnas misippus.** Linnæus.

(Bing. 398 ; deN. 420 ; Ev. F30 (1)).

Is essentially an insect of the plains and is not common so far to the north-west as the Punjab ; but it appears sparingly in Ambala and the country below Kalka. I have never seen it in the actual hills.

120. **Hypolimnas bolina.** Linnæus.

(Bing. 397 ; deN. 419 ; Ev. F30 (2)).

Also prefers the plains but extends well into the hills. I have seen it in Simla, but it is scarce anywhere above 5,000 ft. After the rains is the best time for them.

121. **Kallima inachus huegeli.** Kollar.

(Bing. 403 ; deN. 552 ; Ev. F34 (2)).

The well-known 'Oak Leaf' seen in pretty nearly every collection in India and in every case of exotic butterflies in England. Is not rare anywhere and may frequently be seen in oak woods flashing from tree to tree and suddenly vanishing as it settles. Often quite common in wooded ravines where there is a stream. The undersides of the wings, while always resembling a dead leaf, vary so much in details of pattern, that it is interesting to set a series to show this aspect alone.

122. **Precis (= Junonia) hierta hierta.** Fabricius.

(Bing. 374 ; deN. 349 ; Ev. F35 (1)).

123. **Precis orithya swinhœi.** Butler.

(Bing. 372 ; deN. 350 ; Ev. F35 (2)).

Why the first of these should have been called by the Simla schoolboy a 'Gentleman's Fancy' and the other a 'Lady's Fancy' I was never able to fathom ! Both, in the hills, like open, sunny country, and grass lands in particular, though, in the plains, they flit about gardens and road sides equally freely. The 'Gentleman's Fancy' is rather the less common of the two ; but both will be seen frequently in summer and autumn anywhere up to 8,000 or 9,000 ft.

124. **Precis lemonias persicaria.** Fruhstorfer.

(Bing. 371 ; deN. 347 ; Ev. F35 (3)).

Very common in gardens and open hillsides from spring to autumn.

125. **Precis almana almana.** Linnæus.

(Bing. 375 ; deN. 344, 345 ; Ev. F35 (4)).

Exceedingly abundant in the plains and lower hills, but does not appear to venture freely into the higher ranges. I have seen one or two of the wet season '*asterie*' form in valleys below Simla, but have no note of any appearance in Simla itself.

126. **Precis iphita.** Cramer.

(Bing. 370 ; deN. 343 ; Ev. F35 (6)).

The 'Chocolate' is common pretty nearly everywhere and seems to shun only densely wooded country. Flies from early spring to late autumn.

127. **Vanessa cardui.** Linnæus.

(Bing. 376 ; deN. 520 ; Ev. F36 (1)).

Our cosmopolitan friend the 'Painted Lady'. It is, of course, common everywhere in the district. Towards the plains it is, more or less, restricted to the autumn and winter months, but flies in the hills practically throughout the year. Open ground with thistles scrub is their special home.

128. **Vanessa indica indica.** Herbst.

(Bing. 377 ; deN. 521 ; Ev. F36 (2)).

The Indian 'Red Admiral' is common at all times. Like the last, it loves thistles.

129. **Vanessa canace himalaya.** Evans.

(Bing. 384 ; deN. 522 ; Ev. F36 (3)).

The 'Blue Admiral', though quite as abundant as his red confrère, does not wander abroad so freely. He prefers to keep near running water and will frequently be seen flitting up and down streams. I have also often noticed numbers in small oak plantations. Flies spring to autumn.

130. **Vanessa kashmirensis kashmirensis.** Kollar.

(Bing. 378 ; deN. 525 ; Ev. F36 (10)).

The Indian 'Small Tortoise shell' is such a common sight everywhere that it is quite unnecessary to say anything about it.

131. **Vanessa c-album cognata.** Moore.

(Bing. 385 ; deN. 591 ; Ev. F36 (6)).

Is not uncommon in Kashmir and in the Kulu hills, but is distinctly rare inside the Simla area, though it probably appears more frequently on the interior hills. My only record of its occurrence is one seen (alas, not caught) on a horrible patch of nettles on the Himalaya-Tibet Road near the Wildflower Hotel in Mahasu. This was in June, but the species also flies in the autumn.

132. **Vanessa xanthomelas fervescens.** Stich.

(Bing. 382 ; deN. 528 ; Ev. F 36 (11)).

The large Tortoise shell is not really as uncommon as one might imagine from the very few seen in ordinary collections. The reason for this is its very early and brief appearance. It begins to fly with the first advent of spring and has usually disappeared by the end of May. The valley between Snowdon and the Walker Hospital was a good place for them one year ; and I have also taken one behind Jakko and another (a very *passe* relic of the brood) on Kufri Hill in June. It would probably be more abundant, and perhaps found later in the season, further in the hills.

133. **Symbrenthia hypselis brabira.** Moore.

(Bing. 390 ; deN. 539, 540 ; Ev. F38 (3)).

Somewhat rare in the Simla Hills, but getting less so towards the east. deNiceville took it in the bed of the Simla (Asni) River, and I got a very worn specimen one July in a nullah near Barogh. I have also seen one in a soldier's catch, taken below Dagshai. These records would indicate that it keeps to the lower elevations here, though I have taken it at 6,000 ft. in Mussoorie. Likes wooded ravines and flies summer and autumn.

134. **Symbrenthia hippoclus lucina.** Cramer.

(Bing. 386 ; deN. 532 ; Ev. F38 (1)).

Like the last, not common here though it is abundant from Mussoorie eastwards. It is, however, taken oftener than *brabira* in the valleys near the foot of the hills. Once, travelling up by train, I saw several butterflies which I am certain were this species in the nullah near Jabil station on the Kalka-Simla Railway.

*135. **Symbrenthia niphanda hysudra.** Moore.

(Bing. 390 as *brabira* ; deN. 541 ; Ev. F38 (4)).

Recorded from Kashmir to Kumaon, but is rare everywhere. I have not come across it anywhere in its range.

136. **Argynnis hyperbius hyperbius.** Johanssen.

(Bing. 435 ; deN. 421 ; Ev. F39 (1)).

Not uncommon, though not as abundant, in Simla, as some of the other Fritillaries, or as it is at lower elevations and to the east. A collector is, however, bound to pick up some every year between June and October. Has a preference for open grass country, and, like so many other butterflies, is attracted by thistle flowers.

137. **Argynnis childreni sakontala.** Kollar.

(Bing. 433 ; deN. 423 ; Ev. F39 (2)).

The ' Dun Leopard', as this fine fritillary was called, is generally common from May to October, though it does not fly much during the very wet period of the monsoon. Sunny glades in woods and grass slopes are its favourite grounds and, like the preceding, it is attracted by thistle scrub. Does not go below 5,000 ft. or so.

138. **Argynnis kamala.** Moore.

(Bing. 431 ; deN. 425 ; Ev. F39 (3)).

Appears in May, is very common till July or August, and continues to fly till October. I always found it very plentiful on Mahasu and Kufri Hills, where it flits about gardens and every sunny slope. I have never seen it anywhere below 7,000 ft.

139. **Argynnis adippe jainadeva.** Moore.

(Bing. 430 ; deN. 426 ; Ev. F39 (6)).

Simla itself is rather too low for this species, and I doubt whether it will be found in the immediate vicinity. The late Colonel Chaldecott took several near the Jalauri Pass on the Kulu road, and it should occur round Narkunda and Baghi. Is mainly a summer butterfly, but will be seen, if less frequently, in October and November.

140. **Argynnis lathonia issœa.** Doubleday.

(Bing. 436 ; deN. 429 ; Ev. F39 (8)).

The ' Queen of Spain ' fritillary is exceedingly common above 5,000 or 6,000 ft. at all times from spring to autumn, except during heavy monsoon weather. Avoids deep forest but is otherwise impartial as to its surroundings.

*141. **Argynnis pales sipora.** Moore.

(Bing. 441 ; deN. 432 ; Ev. F39 (13)).

I have not seen this butterfly in the Simla Hills though I know it has been caught in the interior. In Kashmir it keeps above 8,000 ft. and it will probably be found here only above the 10,000 ft. line in the Huttoo and Baghi neighbourhood.

142. **Melitæa arcesia sindura.** Moore

(Bing. 443 ; deN. 309 ; Ev. F40 (5)).

A friend who did a walking trip into the interior and incidentally collected a few butterflies brought back one of this species which he had caught in early June on the way from Kulu. I doubt whether it will be found within the district limits, but it should occur on the inner borders.

143. **Atella phalanta.** Drury.

(Bing. 416 ; deN. 314 ; Ev. F42 (1)).

Very common in the autumn everywhere up to about 8,000 ft. I have not noticed it particularly before the monsoon.

144. **Ergolis merione tapestrina.** Moore.

(Bing. 449 ; deN. 299 : Ev. F49 (2)).

This species, which is always so abundant in its own proper zone, is here nearing the north-western limits of its range. I have seen it at rare intervals near Kalka, but it does not penetrate far into the hills.

(ACRÆIDÆ)

This family is, in the main, an African one and is represented in India by two species only. Only one of these is known to extend into the North-west Himalayas, though it is just possible that stray members of the other may sometimes find their way into the plains bordering on the district.

145. **Pareba vesta anomala.** Kollar.

(Bing. 453 ; deN. 297 ; Ev. F51).

Not common in the Simla area, but an assiduous collector may generally count on getting two or three each season. I have taken it on Kufri Hill and one or two other places in the summer, and it will be found to show up at occasional intervals between 2,000 and 10,000 ft.

Telchinia violæ. Fabricius.

(Bing. 454 ; deN. 298 ; Ev. F52).

A continental species which is common in Oudh and which I know occurs as far to the north-west as Roorkee. There is a possibility that it may sometimes appear in the tract between Ambala and Kalka.

ERYCINIDÆ

A small group of the butterfly family, but the few species by which it is represented in the Simla Hills are, for the most part, common and rather interesting butterflies.

146. **Libythea lepita lepita.** Moore.

(Bing. 455 ; deN. 594 ; Ev. G1 (2)).

Evans' proposed name, the ' Beaks ', or the old Simla schoolboy name of ' Snouters ' are both very apt, as the elongated palpi distinctly suggest some such appellation. *Lepita* is very common about the hills from 5,000 ft. up to at any rate 9,000 ft. You may see them, from spring to summer, round damp roadside drains ; and every nullah has its inhabitants.

147. **Libythea myrrha sanguinalis.** Fruhstorfer.

(Bing. 456 ; deN. 592 ; Ev. G13)).

Not nearly so common in the Simla Hills as the preceding, but the two species are so alike in habits and flight that it is probable that the rarer *myrrha* is often overlooked amongst the crowd of others. Look twice at every *Libythea* that you cannot definitely say is a *lepita !*

148. **Dodona durga.** Kollar.

(Bing 460 ; deN. 597 ; Ev. G3 (1)).

I expect most folk in Simla have noticed this perky little fellow. He flies in his jerky, assured way about the roadside shrubs, and settles preening himself and apparently looking at you. Quite common from June till November and delights in sunny spots where there is plenty of shrub growth.

149. **Dodona dipœa nostia.** Fruhstorfer.

(Bing. 461 ; deN. 598 ; Ev. G3 (2)).

Not at all common in the Western Himalayas, though more frequently met with in the east. Habits and haunts much the same as the next, so it is liable to be overlooked.

150. **Dodona eugenes eugenes.** Bates.

(Bing. 463 ; deN. 604 ; Ev. G3 (3)).

Likes damper and shadier surroundings than *durga* and is best looked for in wooded nullahs and clearings in forests. Is fairly common in such places from May to October.

151. **Abisara echerius suffusa.** Moore.

(Bing. 474 ; deN. 614 ; Ev. G4 (5)).

A common butterfly of the submontane tracts of the Central and Eastern Himalayas, but much rarer between Mussoorie and Chamba. I have taken it near Kalka and it will sometimes be found in the ravines and damper clearings in this neighbourhood. Just before and during the rains is usually its favourite season.

(*To be continued.*)

THE CICADA: *LETHAMA LOCUSTA* WALKER.

BY

C. McCann, F.L.S.

(*With 5 text-figures*).

It is a quiet October evening. Everything is at its best after the four months of rain. The sun is setting behind the Mahableshwar hills. Slowly the song of the various diurnal birds and insects dies out. The sun has gone leaving a faint glow in the sky. There is a lull and everything becomes silent for a little while. The diurnal creatures have gone to their rest and the nocturnal ones are performing their toilet and getting ready for their nightly routine. Night falls—there appears a jackal, he has a look all round to see if the coast is clear. All's well, away he goes slinking along under the cover of some bushes. A Horned Owl sails over my head. Flying-foxes whiz over. I am sitting on the edge of the Tableland at Panchgani. I am not interested in all these prowlers of the night. I am waiting for the nocturnal Cicada (*Lethama locusta*, Walker).* Locally it is known as the *''Croaker''*. They are very noisy creatures and rightly deserve the name. They have already started their chorus down in the valley where it is already darkening. I wait. The sound soon travels up to where I am sitting. It moves up in a regular wave till every bush around me is alive with ''Croakers''. They did not fly there. Where did they come from all of a sudden? Where do they spend their day? What is the meaning of all this noise? These are the questions I set myself, and I try to find the solutions in their behaviour. In the feeble light I closely watch the bushes about me. They are *Lantana* and *Lasiosiphon eriocephalus*, Decaisne. I take up my position near a bush of the former. I see three or four ''Croakers'' making their way up the stems. They have been spending the day at the bottom of the bush in rest.

They are noisy fellows, commencing to croak as soon as they begin to climb up to the branches, from their hiding places. They make for the topmost branches. This answers my first question and also the second. The light is just sufficient to discern them against the sky. The incessant croaking at once gives the position of the songster away. The noise is deafening not unlike the noise of pneumatic drills. I single out one and watch. He is too interested in his ''vocal'' production to take any notice of me. It is only the male who is capable of making himself heard for the females are voiceless. This calls to mind the words of the poet who commented on the bliss of married life among the Cicadas for they have voiceless wives!! They vie with one another in song—they enter into competition and quarrel with one another for positions of vantage. Their quarrels are far from fatal battles. They consist of a ''kicking'' and ''shouldering'' competition. One tries to ''kick'' the other off the branch on which two or more are seated. When they have all left their resting places they frequently fly from one bush to another. "Croakers" from neighbouring bushes frequently come to quarrel with a songster who has already taken up his position. The stronger one succeeds in keeping the perch. The weaker flies off to a nearby branch. The croaking is incessant. The vanquished may be pursued, but there are several others to carry on the pandemonium on the same bush. When fighting the cicadas turn round and round the branch, one treading on the others' "toes", until such time as one gives in.

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* My thanks are due to Mr. W. E. China of the Insect Department, British Museum, for kindly identifying the specimens for me.

Whiz! something passes my head at high speed and alights close to my songster. It is another "croaker" but this is a silent one. Closer examination with the aid of a match (these cicadas are not as shy as the diurnal species, which fly off no soon they see anything moving) shows me that it is a female. She has a long ovipositor which immediately distinguishes her from the male. Besides, she is voiceless, having only rudiments of the song producing organs. There is a stir. My songster is aware of her presence and so are one or two of the others near by. Their song ceases and they move in her direction but slowly—too slowly. My "croaker" has already taken possession of her. Copulation now takes place. The others arrive but too late. Their song is now modified to an occasional croak. They crawl over and around the couple, but the latter are quite unconcerned. Disappointed, the rivals retreat to a little distance and commence their song with renewed energy in the hope that some other prospective mate might hear. In the meantime another female arrives and the process is repeated. The act is partially dorsiventral and is completed in three to four minutes. All this time my box of matches helped me to watch the process. When the act has been consummated the female is released. The male is now silent and settles down to the more important business of feeding. The female goes off. This small observation answers the third question. The females of this cicada are attracted by the song of the males. Their song is a 'mating' song. It ceases completely after copulation.

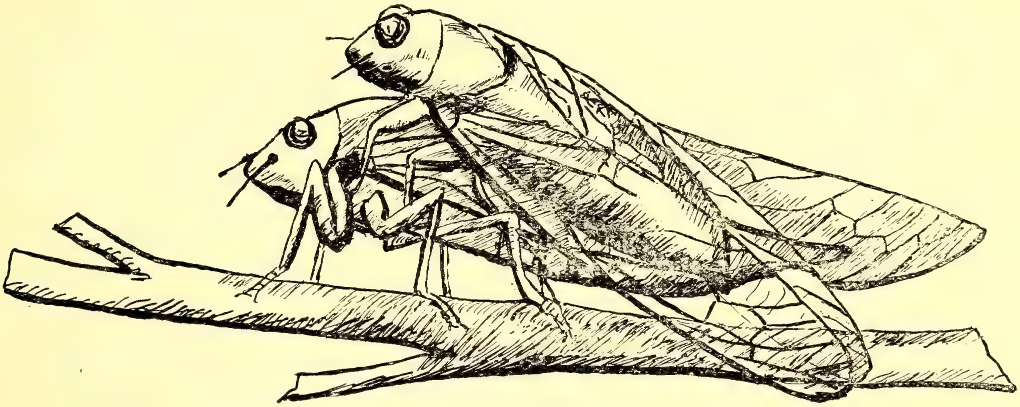


Fig. 1. Position of the Cicadas in copulation.

I am satisfied with my answers and so I sit listening to the chorus around me. It gradually dies down. Then everything is quiet once more. The concert has ended. The performance only lasts for about an hour or a little more. The rest of the night is spent in feeding and in the meantime the females may be also laying their eggs.

Next morning I visit the same locality. Not a "croaker" is to be seen in the neighbourhood. Occasionally, a belated reveller, intoxicated with the juice of plants may be found lying about in the grass. He is silent but as soon as I pick him up, he utters short protestations by way of croaks indicating his disapproval of my interruption of his slumbers. However, had I not picked him up, he would probably have fallen a victim to the Kites (*Milvus govinda*) which were already on the prowl for insect food in the short grass —a daily proceeding of these birds in this particular locality.

During the time that these cicadas are wont to perform their "shrieking chorus", handling does not seem to retard the volume of sound produced in the least. A captive will continue his music in your hand.

The Mechanism of the Sound-Organs.

The "vocal" efforts of cicadas are well known to most people. The intensity of the sound depends much on the size of the insect and on the type of "instrument" "he" is supplied with, for "she" is silent. Above I have given sufficient evidence to prove that the song of the cicadas is an expression of their sexual feelings and at the same time is really an attraction to the females which respond to the invitation. But to explain the way in which this song is produced is quite another matter. It cannot be termed vocal for as is well known there is a special apparatus for its production.

The first record of the song of cicada was made apparently in the eighth century before Christ, by Hesiod, who states that the cicada "pours forth *from under his wings,* his shrill song". As far as it goes his observation is correct. Aristotle and many other later observers believed that the sound was produced by respiration. This view was held for a considerable time and was perpetuated until it was disputed by Casserius and Galileo. Galileo's statement swept the board of the old traditions and was a clear conception of the modern spirit. Giulio Casserio (Casserius), a contemporary of Galileo, had already discovered the effective organs of the cicada's sound, even before Galileo. In 1600 he published a detailed account of several species, illustrating the tymbals and also the muscles. But we owe much to Réaumur (1740) whose accurate observations were confirmed by Carlet (1876) and other workers.

To be able to understand this most complicated and interesting sound-organ we must make a careful survey of all the parts concerned, both internally and externally. The rudiments of these organs are met with in the females but they do not function, hence all our remarks must necessarily be confined to the opposite sex in which the sound producing organs are developed to a remarkable degree, so much so that they have developed at the expense of all the other internal organs, which have been reduced to a minimum.

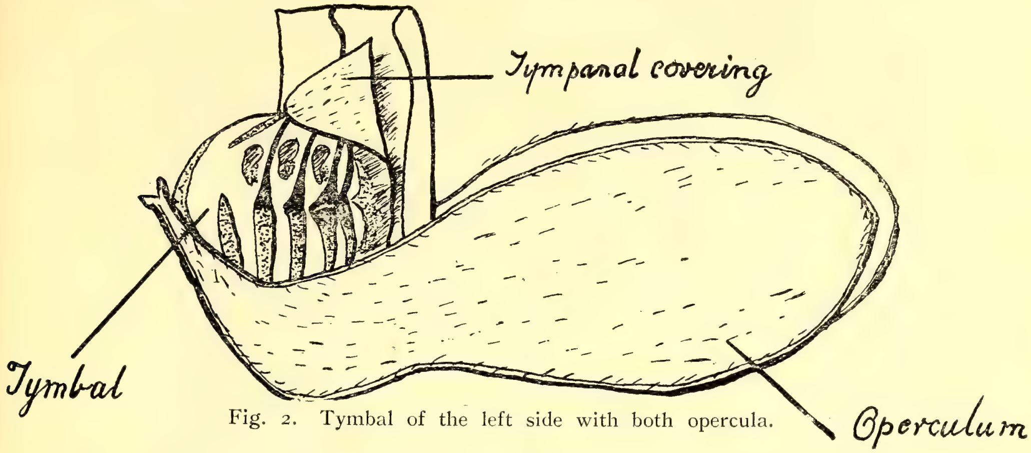


Fig. 2. Tymbal of the left side with both opercula.

If the fingers are passed over the abdomen of the cicada, it will at once be noticed how papery it is. Cut it in two longitudinally. It will readily be seen how empty the abdomen is—perhaps there are no internal organs! No! these are all reduced in size and are fixed to the dorsal region of the abdomen. In order that it may freely serve the purpose, it has now become a resonator—empty vessels make the most noise! The thoracic region is full of powerful muscles. The anterior part of the thorax is divided from that part which is continuous with the empty abdominal cavity, by a thin wall of chitin. In front of this wall are the muscles connected with flight and behind it one large, broadly conical muscle, the pair to this one is in the other half of the body. These two muscles are by far the largest muscles in the whole anatomy of this cicada and are devoted to the sole purpose of working the "instrument" with which these creatures make their "big noise" in the world. We shall have occasion to refer to these muscles later.

On either side of the abdomen in the present species there is a large obovoid plate constricted below the middle and then narrowed into the base where it is attached. These are the *opercula* (fig. 2). These plates are fixed and are not capable of any movement. They assist in directing the sound waves over the surface of the hollow abdomen, thus increasing the volume of the sound produced. Now we come to remove an operculum and cut away a portion of the abdominal wall to see this part of the apparatus in operation. At the basal end of the opercula, and partly covered by them, are two small highly convex structures composed of a thin flexible membrane reinforced with strongly chitinised ribs and plates of a reddish-brown colour. These are the *tymbals* (figs. 2 & 3). The tymbals are in a strong chitinous frame which borders them on all sides. The ribs and plates help to produce the sound and at the same time act as a spring, bringing the tymbals back to their original position after deflexion. The tymbal is somewhat triangular, though it appears circular when in position on the insect. At the posterior margin of the tymbal, which would correspond to the base of the triangle, there is a large chitinous plate somewhat triangular in shape—this I propose to call the *plectrum* (fig. 3). This plate is larger than the others and the thickness of the chitin is varied at different points, the surface being somewhat undulate. At the dorsal angle of the triangle the chitin is extremely thickened in the form of a broad inverted Y (fig. 3, a). The top angle (that pointing in the direction of the head) has an obtuse *beak* (fig. 3, b)—the point of the plectrum. The other portions of the plectrum gradually fade away into the membrane of the tymbal. So much for the present about the externals of the "instrument", now let us have a look into the body. In the longitudinal section we noticed the large broadly conical muscle arising from the last segment of the thorax. This is the *tymbal-muscle* (fig. 4). It is surmounted by a thin chitinous

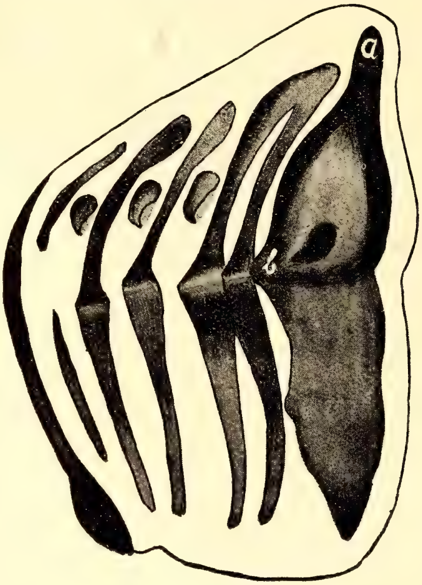


Fig. 3. A single tymbal showing chitinous ribs and plates. *a*. Y-shaped end of *plectrum*. *b*. Point of *plectrum*.

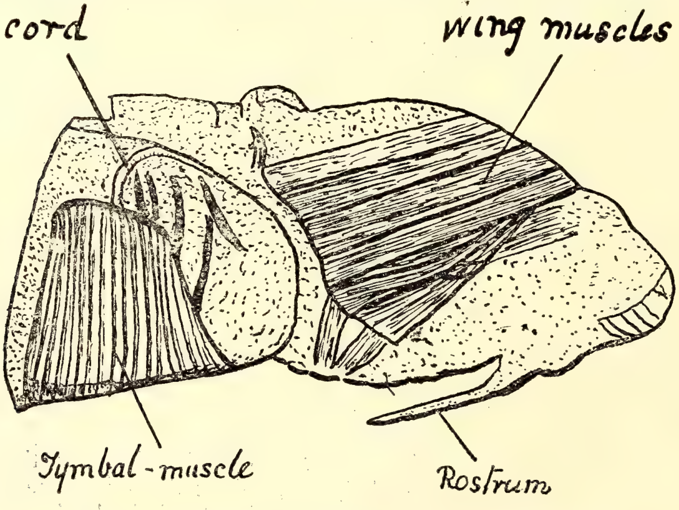


Fig. 4. Longitudinal section showing the muscles.

plate on the top of which is a thin chitinous cord. This cord is attached to the stem of the thick Y-shaped angle of the plectrum, already referred to. In cross section the tymbal-muscles are seen to be united at their bases, but the upper portions diverge from one another in the form of a V (fig. 5). They are the largest muscles in the body and are composed of a bundle of muscle strands, giving them a striated appearance.

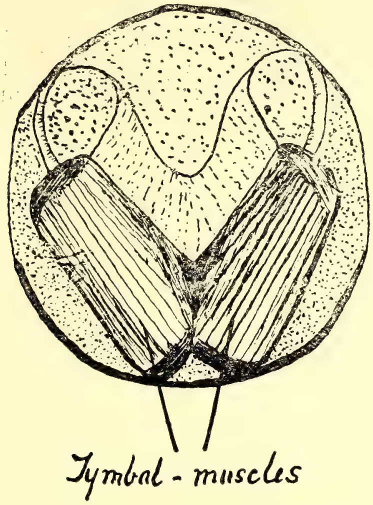


Fig. 5. Section showing both tymbal muscles.

Let us examine the outside of the tymbal once more. As we have seen, there are chitinous ribs and plates on its surface. The ribs are important and call for our attention first. There are four in number crossing the surface of the tymbal. In their upper half they are more chitinous than in the lower, particularly at the centre. The two anterior ribs are free, but the two posterior are united at the top and at the middle forming a solid mass, the lower ends are free. When the tymbal is deflexed by the contraction of the tymbal-muscle, the upper portion of the tymbal alone (about 2/3) is deflexed. On relaxation of the muscle the ribs spring back to their original position. Now to follow the action of the whole apparatus. When the tymbal-muscle is contracted, the cord which is attached to the plate on the top of the muscle is pulled. The other end of this cord is attached to the stem of the Y-shaped angle of the plectrum. This tension deflexes the plectrum, the beaked (or anterior) angle of the plectrum crosses the thickened portion of the fused ribs, at the same time the rest of the tymbal is deflexed. When the beak of the plectrum crosses the fused ribs there is a click and when the muscle is relaxed the same click is repeated, just in the same way as a true plectrum is used on the string of a banjo. Now in the cicada the tymbal-muscle contracts and relaxes at a tremendous speed bringing the plectrum into play as described above, thus giving rise to the noise made by the cicada. The sound waves are conducted over the hollow abdomen by the opercula. They function in much the same way as a hand placed above the mouth of a singer can increase the volume of sound. Thus the clicking sound is magnified to the tremendous din.

In order to verify my observations, I performed the following experiments with living cicadas. I might mention here that this particular species does not modify its production when handled. In the first place I was anxious to see whether one tymbal was able to operate without the other. With this object in view, I first obstructed the action of one tymbal—the other continued to function. I then cut out the tymbal of one side—the result was the same. Lastly I injured the tymbal-muscle of one side with a like consequence. The next point that drew my attention was the opercula. Partial removal of one or both had no perceptible effect on the volume of sound, but when both were entirely removed there was a slight change in the volume of sound. In the next experiment I made a hole in the abdomen with the effect that the sound was considerably modulated. With the removal of the entire abdomen, the sound was reduced to a minimum—it was a little more than just audible.

The result of the experiments are thus reduced to (*a*) one tymbal is capable of producing sound independently of the other; (*b*) the opercula are only conductors of the sound waves; (*c*) the abdomen is reduced to a resonator.

REVIEWS

I. BIRD LIFE IN INDIA by Captain R. S. P. Bates, M.B.O.U., x + 187 pp., $9\frac{1}{2}$ ins. × 7 ins., with a map and sixty-two black and white plates, and frontispiece. Published by the Bombay Natural History Society. Price Rs. 9. (to members Rs. 6-12)

The untiring efforts of the Bombay Natural History Society to promote an intelligent interest in all branches of natural history in this country are too well known to need special comment. Witness for instance the numerous excellent publications it has placed before the public in recent years including, among others, the charts for the identification of poisonous snakes, the Butterfly book by Col. Evans, the sumptuous volumes dealing with the game birds of India by Stuart Baker, and the sets of charts illustrating in colour over 200 species of the commoner birds of the Indian plains. To this creditable array has lately been added the book under review.

Captain Bates, the author, is familiar to all readers of the Journal through his beautifully illustrated and charmingly written articles on Indian bird life which appear in its pages periodically—though unfortunately not as often as we should like to see them. As pointed out in the preface, a great part of the subject matter of the 11 chapters that go to comprise the book is a recasting of the articles that have appeared from time to time in the Society's Journal, and among the illustrations likewise readers will recognise a number of old friends. Their publication in book form, with the addition of hitherto unpublished material both in the letterpress and photographs will, we trust, serve to bring the fruits of Captain Bate's painstaking observations and infinite patience before a still wider circle of readers. Popular works on Indian Natural History are few and far between and we are sure all nature lovers will welcome the advent of this publication.

The fascinating sport of bird photography in India, despite the almost unparalleled facilities the country offers as regards lighting conditions and abundance of bird life, is still in its infancy. It undoubtedly presents a great many difficulties, besides which the climate, especially in the plains, is a factor to be seriously reckoned with when working from a hide. The last two chapters of the book entitled 'Experiences with Natural Hides' and 'A Bird-Photographer's Needs' are particularly illuminating, and we would commend them particularly to those about to begin, or have abandoned in disgust or despair, the hobby of photographing Indian birds. Captain Bates' achievements entitle his hints and suggestions to the right of being treated as authoritative, and his photographs demonstrate the high degree of success that can be attained through patience and attention to detail.

We heartily commend this book to every nature lover in general and to every bird-photographer in particular, be he old or young, would be, successful or otherwise, and are sure that all will read it with pleasure and profit.

A word of praise is due to the printers of the plates, the *Times of India Press*, Bombay, whose name we find has been inadvertently omitted on the title-page. The reproductions of the photographs are excellent and reflect great credit on the Press.

The only fault we have to find with the book is in its binding, a defect all the more deplorable since in the line of popular natural history works the get-up plays a most important part in the selling-power and circulation of a book. In these days of financial depression, however, it was imperative for a work that would be popular to be at the same time inexpensive, and it cannot be denied that the price fixed for this book, embellished as it is with such a large number of plates, brings it within the reach of all. We hope it will meet with the success and popularity it deserves.

S. A. A.

II. DIFFICULTIES OF THE EVOLUTION THEORY by Douglas Dewar. Published by Edward Arnold and Co., London.

The author has clearly been very much impressed by Vialleton's 'Morphologie gènèrale' and in the course of compiling the present volume (I use the term compiling deliberately, for a large part of the book consists of abstracts or quotations from other authors) has clearly read a number of works on various branches of science. Unfortunately, the result appears to be a kind of mental indigestion.

At the outset one is faced with the difficulty of discovering what exactly Mr. Dewar means by the term evolution; so far as I have been able to discover, the author would apply this term solely to those cases in which the change from one form to another has been by gradual and almost imperceptible stages, i.e., evolution in the strictly Darwinian sense, whereas changes that have been brought about somewhat abruptly, as by mutation, he would regard as creations. A close study fails to show whether Mr. Dewar agrees with and accepts the time-honoured dictum *Omne vivum ex vivo*, or whether he genuinely believes that each main phylum and even some of the smaller groups in the great biological kingdom have arisen as special creations, using the term in its generally accepted sense to mean the creation of a living organism by supernatural powers out of non-living material. At one time he appears to hold this latter view, namely that 'each creation is the embodiment of a divine idea, or that organisms have been created out of nothing by the mere fiat of the Creator'; but in other places he seems to regard 'the rearrangement of the structural elements of some earlier organism or a change in the development of some embryo' as an act of creation. In his definition of a special creation as 'a new kind of organism which has had an abrupt origin or made a sudden appearance, as distinguished from a gradual transformation through successive generations of some earlier organism' the author tries to so widen the ordinary meaning of the term 'creation' that it can be used to include, on the one hand, the formation of a complex living organism out of nothing or at least out of non-living matter, i.e., a miracle, and, on the other, those mutations that, one knows, occur in nature and that can be induced experimentally in organisms by the application of some unusual environmental condition, such as X-rays or a modified food-supply. Every biologist will agree that, so far as the geological record goes, new types make their appearance suddenly in the succeeding strata; but that is a very different thing to believing that because their appearance is sudden these types have been specially created; and no one with an adequate realisation of the intermittent manner in which these fossiliferous strata have been laid down and the thousands of years that may have elapsed between the deposition of one stratum and that immediately preceding or succeeding it, would be so surprised, as Dewar appears to be, that 'the fauna and flora of a horizon differ very markedly from those of the horizon immediately below"; neither would they accept Mr. Dewar's final summing up (p. 155) that 'the correct scientific attitude, in the present state of knowledge, is to recognise that in the past new types have made an abrupt appearance, and to admit frankly that at present we are quite unable to point to any natural forces capable of originating them; in other words, to revert to the theory of creation,' nor that it appears 'to be necessary to adopt a provisional hypothesis of special creation, . . . supplemented by a theory of evolution.'

Much knowledge has been acquired since Darwin first postulated his great theory and it has been found necessary to modify the theory to some extent; the hope that future paleontological research would reveal missing links connecting the great phyla has been abandoned and it is now recognized that the evolution of these main groups took place at a very early stage in the history of the biological kingdom but it is also becoming more and more widely recognized that the further we go back in the past the more plastic were the then existing animals and plants; and it is probable that, correlated with the greater instability of the earth's crust and of the physical conditions existing thereon, this greater plasticity may have permitted those abrupt changes or mutations, that still occur even in the most highly specialised and therefore most fixed forms, to be of much greater range and importance, even of sufficient importance to have caused the mutation of one phylum from another. To seek for the origin of the great phyla one has to go back beyond the Protozoic era, but that is no argument in favour of adopting a belief in special creation.

The book contains some glaring inaccuracies; zoologists will be amazed to read that 'the structure of the pelvic (hip) girdle differs fundamentally in the two classes (Reptiles and Mammals). In Reptiles it articulates with the sternum (breast-bone) by means of the coracoids, and forms part of the thorax', and again, that 'the Reptiles have two aortae; the mammals have but one—the right'.

R. B. S. S.

MISCELLANEOUS NOTES.

I.—LOCAL MIGRATION OF THE FLYING-FOX (*PTEROPUS GIGANTEUS*) IN THE PUNJAB.

The Flying-Fox (*P. giganteus*) remains in the Gurdaspur District of the Punjab from March up to the end of the fruit season.

This year the first arrivals were seen by me on the 3rd. of March. They are not very numerous as yet—food is not plentiful—plums and *Bombax* are the only trees that provide them with food. Later they will be in thousands.

Gurdaspur,
Punjab.
March 18, 1931.

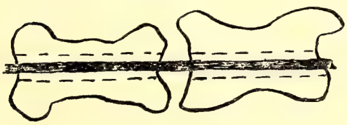
G. BREADON,
District Engineer.

II.—VITALITY OF A COW MAULED BY A TIGER.

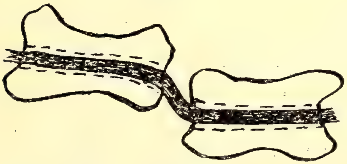
(*With two text-figures*).

A case of a cow that was scragged by a tiger, and then ran about 40-50 yards with a broken neck before it collapsed dead occurred near here recently. The kill, a natural one, was the work of the fifth tiger (rather tigress) of the group of five I recently had the fortune to bag. I was shown the spot where the tiger had obviously first felled the cow (signs of the struggle, blood, and hair were there in plenty), and then 40 or 50 yards below the kill itself, a cow in its prime, with neck broken. This was interesting, and on writing to Major P. T. Saunders, Director of Veterinary Services, Madras, on the matter I received the following reply:—'I have your letter with the query about the cow with the broken neck. It is really most interesting but is certainly possible. Had the neck been broken, i.e., with displacement of the parts, the cow could not have run 50 yards, as pressure on the spinal cord would mean loss of both sensation and control. In my opinion what occurred was that the "break" took place where the tiger tackled her but displacement of the parts was not immediate and took place later. Imagine Fig. A showing two neck bones, the dotted lines showing the canal for the accommodation of the cord, and the dark part the cord itself. The dislocation of the joint might occur and the parts still remain in position. Then by a muscular action of the cow's neck the displacement (actual dislocation) takes place later thus (Fig. B.). The ligaments etc., holding the joint in position

A



B



were no doubt destroyed at once. Similar cases have occurred in men.'

Honnametti Estate,
Attikan P.O.,
Via Mysore, S. India.
March 3, 1931.

R. C. MORRIS,
F.Z.S., F.R.G.S.

III.—A PANTHER'S STRANGE BEHAVIOUR.

In December last a couple of panther (male and female) came to a kill R. E. W. of Madras and I were sitting up over, (time, 8 p.m.—moonlight). The male commenced to feed and was shot dead on the kill. The female immediately started to perform an extraordinary set of evolutions which lasted for about 10 minutes—rushing up and down across our front, kicking up an almighty din the whole time, seizing and shaking the kill and its dead mate, and repeatedly taking at a bound a high rock in front of us. We received the impression that had she discovered our presence on the small, lone tree we were on, she would probably have taken our machan at a bound too, possessed with the devil as she seemed to be. When she finally quietened down and cautiously approached the kill, a shot laid her low beside her mate—so in death they were not divided.

Honnametti Estate,
Attikan P.O.,
Via Mysore, S. India.
May 18, 1931.

R. C. MORRIS,
F.Z.S., F.R.G.S.

IV.—CANNIBALISM IN PANTHERS.

Cases of cannibalism by the greater Carnivora have been occasionally recorded in the Society's *Journal,* but incidents of this nature are always of interest. The following is an account of a recent happening near Pachmarhi, which is of added interest, as a further indication of the well-known boldness of most wild animals during the hours of darkness and twilight.

Captain G. W. N. Barefoot, M. C. and Mr. B. M. Pratt write:—"We were motoring down a ghat road about 11 o'clock on the night of June 6th, and by the light of a hand torch saw by the roadside the reflected light of several eyes. Having stopped the car, we searched about in the bamboo forest with the torch, and about two hundred yards from the road came to a dry nullah, on the further side of which there was rising ground. The eyes were now seen up the slope, but we were not able to make out the owners of them sufficiently clear for the purpose of a shot. Half an hour passed by without the beasts changing their position, so we threw stones, and made noises, in the hope of moving them to a place where Mr. Pratt placed himself in waiting. Eventually a No. 4 shot was fired in their direction which disturbed them, and after about ten minutes, caused one of the animals to show itself about thirty yards from Mr. Pratt, who fired at it with his 12 gauge shot gun (lethal bullet). The animal leapt in the air, ran some yards, and then sound ceased. Throwing of stones produced no response, but it was thought best to leave the possibly wounded beast until the morning. The other two animals remained exactly where they were, hidden behind clumps of bamboo, and out of range, but after fifteen minutes their eyes were not to be seen. We returned at an hour before dawn, and approaching the place found one panther eating something where the body of the animal fired at should be; but on account of the darkness could not make it out clearly enough for a shot.

On our nearer approach it moved off, and we found our panther had been eaten. The skin had all gone from one side of the stomach, and there was a deep gash in the cheek; it resembled, in most respects, a natural kill, although the bullet must have killed it outright, having entered just behind the shoulders.

It was a male and measured 6 ft. 4 ins. Probably the party was a female with two almost fully grown cubs. We followed after the cannibal for some time, and saw two panthers moving rapidly up a dry nullah, but could not obtain a shot at them."

Mr. Pratt tells me he has killed 6 panthers during the past two years by spotting them with a torch from a car, and then following them up in the forest with gun and torch.

Until a shot is fired, and a hit made, there is probably but little risk in this method of panther shikar; but following the perforation of the target any kind of excitement may eventuate.

Long life to this young sportsman, who has shown the way to thrills which may attract even the most blasé of shikaris! The great majority of sportsmen condemn all shooting with aid of a motor car as unsporting; but so long as the shot is not taken with the direct aid of the car, but in the manner here indicated, it will, I think, be agreed that this method of coming on terms with tiger and panther may be considered permissible; provided, of course, that any beast wounded must be next day followed up in the usual way.

PACHMARHI, R. W. BURTON,
June 12, 1931. *Lieut.-Colonel.*
Indian Army (retired).

V.—SOME SUGGESTIONS ON PANTHER SHOOTING.

I do not know how far this will appeal to the sportsman in general, but as I have myself tried it many times and with success, I offer the suggestion for what it is worth.

It is not unusual that the bait tied up to obtain a panther kill is carried off by a Hyæna and much time, labour and energy is lost.

One method of circumventing the prowling hyæna is to tether the bait on a small machan, a rough platform, 5 ft. × 5 ft., raised on poles say about 4 ft. 6 ins. from the ground. If this is done hyænas will leave the bait alone and if a kill is made one can be certain that it is the work of a panther. The ground below the platform and for three feet around it should be cleared and, if sprinkled with sand, will reveal pug marks.

AMBIKAPUR,
P.O. SURGUJA, C.P.
June 10, 1931.

RAMANUJ OF SURGUJA.

VI.—THE NUMBER OF PUPS IN A WILD DOG'S LITTER.

With reference to Miscellaneous Note IV at page 1055 of Vol. xxxiv, No. 4, I have seen seven pups with a wild dog bitch which brought her family to a panther kill. A friend says he has seen ten pups with a bitch, but in both these instances it might be that the pups belonged to two mothers, though that is not likely. But another friend tells me that he himself saw seven embryos taken out of a wild dog which was shot. When he sees this note perhaps he will give the date (which I forgot to enquire) as evidence of the breeding season.

PACHMARHI,
June 28, 1931.

R. W. BURTON,
Lieut.-Colonel.
Indian Army (retired).

VII.—AN INCIDENT WITH WILD DOG IN NIMAR.

In March 1930, a friend and myself were the victims of an unusual encounter with Wild Dog. On the night of the 9th. and 10th., a bait, tied up at the junction of a cart track and a nalla which held several pools of water, was killed by a tiger whose pugs were clearly imprinted in the sand. Visiting the spot in the early morning we selected two trees for our machans, each about 30 yards from the kill, as we hoped to get a shot by daylight. We covered up the kill and left two men on guard to see that nothing was disturbed.

Early in the afternoon the shikaris were despatched to tie up the machans and we followed shortly afterwards in a bullock cart.

The last half mile of our road lay over an open maidan covered with short spear-grass and having here and there a thin clump of trees. As soon as we entered this maidan we came on a pack of Wild Dog, some dozen or more strong, lolling about under a clump of trees about 100 yards off the road. We stopped and debated whether or not to open fire, since, though we knew that to do so would probably ruin our chances of getting the tiger, yet we had good cause to suspect that it was due to the presence of these Wild Dog in our block that we had hitherto had no success and it seemed a pity to let the pests escape. Eventually, however, we decided against firing and moved on; the dogs, mean-while, had not taken more than a mild interest in our proximity. A few minutes later, topping a slight rise in the ground, we sighted three or four nilgai bunched together in the open; these stood at gaze for a moment and then cantered off for the edge of the forest. I think we must have cut in between the dogs and their quarry.

On reaching our destination we found that our shikaris had seen nothing of the dogs on their way so it seemed unlikely that the latter would remain in the vicinity, but, to make certain of this we sent two men who had been on guard to drive them off in the opposite direction.

It was not long before we settled down to our vigil.

Before sunset our only visitors were a solitary langoor and a couple of peafowl; but as soon as the full moon was flooding the open grassy stretches with silver light, the teak-clad slopes of the low hills to my front began to rustle with the movements of sambar coming down to drink at the pools a hundred yards or so behind me. Soon small groups of deer could be seen silhouetted against the silvered grass.

Next a rustling in the grass from behind my friend's machan set my pulse beating, but, after an eternity of waiting, it materialized into a *chausingha,* or four-horned antelope, also on its way to drink. The little creature made a tremendous clatter moving down the stony nala-bed, as if it had not an enemy in the world.

The hours dragged on and the sambar were back again in their hillside and I was brooding on the many disappointments of shikar, when the silence of the night was rent by a deep and throaty snarl, some distance away. After what seemed an age two small black shapes trotted out of the long grass and made straight for the kill. At first I thought they were jackal; but, when, after a sniff at the carcase, they retreated only to return in a moment, followed by the remainder of the pack, and without further ado fell to tearing at the kill, it was clear enough that we had not seen the last of the Wild Dog.

All other means of persuading them to decamp having failed, I fired 'into the brown' which had the effect of making them scatter, but not by any means clear out. In a minute or two the bolder ones were moving back to their interrupted meal. Again I fired, again without recording a hit, but this time they seemed to have had enough and disappeared.

We now gave up all pretence of keeping quiet and discussed the situation and the *pros* and *cons* of a proposal to return to camp; before, however, we had come to an agreement on this point, we were interrupted by a commotion arising on the hill slopes whence the sambar had come earlier in the night.

The sound grew rapidly closer and now above the noise of the stampede rose a frenzied whimpering cry. I have only heard Wild Dog give tongue once before and on that occasion we had surprised two drinking and my friend bowled one over and the other circled around out of sight calling—quite a different call. Perhaps what we now heard was the cry of pups as we had noticed some half-grown ones with the pack in the afternoon.

A few minutes later a confused black mass of flying shapes came out into the moon-light, heading straight towards us, and, ceasing to advance when exactly opposite my friend's machan, began to revolve, as it were, on its own axis.

After a bit I made out a sambar in the middle of the *mêlée,* and my friend, who was closer and could see better, shouted that the dogs were pulling down two sambar and that he was going to fire.

Two shots crashed out and a sambar hind plunged off past me and away. My friend reported that he had missed with both shots but that the dogs had cleared leaving one sambar apparently dead; but whilst we were still talking the poor brute staggered to its feet and came tottering towards me. It paused for a moment under my machan and I turned my torch on to it but could see no trace of wounds; then it slowly made off towards the pools behind.

Poor brute! We wondered what would happen to it and we were not long in doubt. We heard it bell from the water and once again the whimpering cries arose. Then came a scream followed by awful moans of agony as the wretched creature was torn to pieces.

At dawn we visited the pools and found the signs only too clear to read. A scoop in the sand at the edge of the deepest pool showed where the sambar had been dragged forth. Higher up the bank the boulders were stained with blood and here lay the stomach and there six inches of the tip of its tail.

AHMEDABAD. R. M. SIMMONS.
March 23, 1931.

VIII.—THE MITHUN.

Your correspondent in the last issue of the Journal, through ignorance of the Assamese language, does the Burma Forest Department an injustice, when he accuses them of jesting at the expense of the shikari, in issuing a permit to shoot *mithan.* The Assamese use the word *mithun* (not *mithan*: the name is spelt correctly by Carey and Tuck in the *Gazetteer of the Chin Hills* and by Sanderson, in *The Wild Beasts of India,* but wrongly by your correspondent and most other sporting writers, including Lydekker in *The Game Animals of India*) indiscriminately, when speaking both of *Bibos gaurus* and *Bibos frontalis.* In fact, to most Assamese the word would probably call up the image of the *Bibos gaurus,* as only those living near the hlils on each side of the Brahmaputra Valley have seen *Bibos frontalis.* Probably the list of protected animals and permit to which your correspondent takes exception were drawn up by some Conservator who had served in Assam.

Among the Kuki tribes inhabiting the Manipur Hills the *mithun* was, until recently, the only bovine domestic animal. Together with the gong and cornelian beads, it constituted their currency, and penalties for breaches of their primitive code of laws, as well as the price of wives, were calculated mostly in so many head of *mithun.*

The Chins (who are closely related to the Kukis) are probably correct in making the *Bibos frontalis* the offspring of *Bibos gaurus* and domestic cattle, although it has now become a separate species. The Kukis practically cleared the Manipur Hills of bison upwards of half a century ago, and mating of *Bibos gaurus* either with *Bibos frontalis* or domestic cattle is quite unknown nowadays. But *Bibos frontalis* is a fertile species, and breeds freely. The bulls also interbreed with domestic cows. Crosses are not uncommon among the Naga tribes of the Manipur Hills, who keep cattle as well as *mithun.* I have never known the crosses to interbreed with each other or with domestic cattle in these hills, but I knew a case on the Kuturi Tea Estate, in the Nowgong District of Assam, where a cow, bred from a *mithun* bull from the Aka Hills and a domestic cow, bore a calf to a domestic bull. I have often wondered whether the sturdy black cattle kept by the Naga tribes in these hills do not possess a strain of *Bibos frontalis.* I met one instance of a cross between a bull of *Bibos frontalis* and a domestic buffalo cow. The animal could hardly be distinguished from a pure-bred buffalo. I never ascertained whether it interbred with buffaloes.

It is not correct to say of the *mithun* of the Manipur Hills that "all the domestic cow's varied colours appear". They are all black and white, as in your correspondent's excellent photographs (calves are brown and white until they are a few months old, when the brown changes into black). The majority are coloured like *Bibos gaurus,* with black bodies and legs and white stockings, but a number are piebald, though always in black and white. Occasionally the white prevails over the black.

The *Bibos gaurus* is not always "a very silent beast". I remember taking a friend out in a remote forest in Nowgong, where *mithun* (bison) were very plentiful, and we were surrounded by animals bellowing loudly in the early morning. Sanderson rightly describes the noise as follows:—"It closely resembles a common sound made by elephants. It is used by bison to call each other at a distance, and can be heard for about a mile in favourable ground. It may be described as a sonorous bellow". Not unnaturally, it even more closely resembles the sound made by *Bibos frontalis.*

I have never had the misfortune to encounter a savage specimen of *frontalis.* In return for a little salt they will usually follow one about the village.

THE RESIDENCY,
IMPHAL,
MANIPUR STATE.
July 27, 1931.

J. C. HIGGINS,
I.C.S.

[The spelling of the word "mithun" as "mithan" in Mr. Livesey's recent note was due to the Editor's following the spelling adopted by Blanford in the *Fauna of British India, Mammals.* Eds.]

IX.—THE SHWE-U-DAUNG GAME SANCTUARY, UPPER BURMA, WITH A NOTE ON THE ASIATIC TWO-HORNED RHINOCEROS (*R. SUMATRENSIS*).

(*With a plate.*)

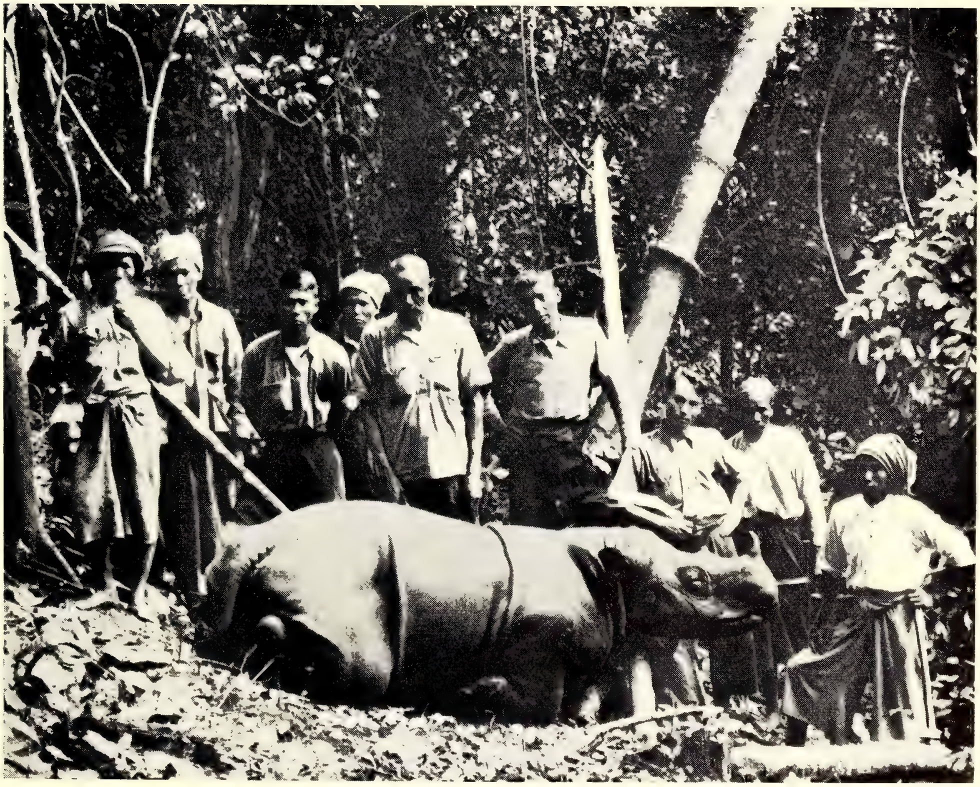
I enclose some notes and photographs taken by me during a fortnight's tour in the Shwe-u-daung Game Sanctuary in Upper Burma. They may be of interest to readers of the Society's Journal.

The Sanctuary extends over 126 square miles; 75 per cent of which is heavily afforested. The more elevated portions of the Sanctuary assume the form of a high watershed which stretches for about 10 miles at altitudes varying from 4,000 ft. to 6,223 ft. on the Shwe-u-daung peak. The main peaks, the ridge, and most of the high spurs leading from it are partly or altogether bare of tree growth over considerable areas. They are covered by a coarse grass which is from 1 to 3 feet high on the higher slopes; but this gives way to very high *kaing* grass in depressions and on the borders of the forests which clothe all the lower portions of the Sanctuary. The climate on the main ridge is cold and bracing, and with the exception of a few blood-blister flies most of the insect pests found lower down are absent.

The three main peaks; Shwe-u-daung, Nanmadawgyi, and Nanmadawgalay are popularly supposed to be the abode of certain *Nats* (spirits,) which are held in some reverence by the Shan villagers near the Sanctuary, and serve most opportunely to preserve the sanctity of this stronghold of wild game. It is an area the high ground of which is eminently suited to be a National Park of the future. The transition to this desirable end must be gradual; but it is hoped that it will not be very long before the communications are improved and this area made available as a resort of every lover of nature and wild animals.

All species of animals indigenous to Northern Burma with the exception of Thamin, Goral, and Hog-deer are found within the Sanctuary. Saing (*Bibos banteng*) are found on the low ground in the western parts of the Sanctuary but do not climb high into the hills. With this exception, all the species may be found in due season on the open grassy slopes on and near the main ridge. During my visit from October 24th to November 6th the grass was too coarse to attract Bison to the main ridge and only one herd of 15 was seen out in the open. Sambhur, however, were plentiful and were on view in the open at all hours of the day in herds of from 3 to 10 individuals. They are not shy; but being unaccustomed to the sight of human beings desert the open ground for a few days after seeing men. This fault can be easily set right during the transition stage between a Sanctuary and a National Park. In March to May the numbers of animals on view would be far greater.

THE SHWE-U-DAUNG GAME SANCTUARY.



THE ASIATIC TWO-HORNED RHINOCEROS (*R. summatrensis*), SHOT IN THE SANCTUARY.

Experience in other countries has shown that in order to persuade wild animals to remain on view in the open, they must be made accustomed to the sight of men. In my experience in the Sanctuary, areas in which animals were seen on the first day were deserted on the next, and this is bound to be the case in an altogether secluded area. The regular patrolling of the Sanctuary by reliable keepers and the gradual construction of paths and buildings will, far from disturbing the game, make them indifferent to the sight of men.

Heavy mists are the rule at high elevations within the Sanctuary during the rains and the early part of the cold weather. During more than half my time in the Sanctuary photography was at a discount owing to mists and some rain. During the dry season however and especially in March, April and May, the Sanctuary would be a paradise to the keen photographer of wild animals.

One tiger was seen right out in the open. They are splendid creatures; but disturb the deer on the main ridge and should be destroyed.

In addition to a large number of sambhur, I saw within a fortnight three rhinoceros, one solitary bison, one herd of fifteen bison, one tiger, one elephant, one barking deer and six pigs.

The accompanying photograph is of a male Two-horned Rhinoceros (*Rhinoceros sumatrensis*), shot within the Sanctuary under the direction of the Local Government for museum purposes on the 27th October, 1930. The skin and skeleton have been presented to the British Museum for mounting.

The destruction of this animal is less to be deplored than might be apparent, as there are fully ten other rhinoceros living in the Sanctuary under conditions ideal for their continued existence and increase. The specimen depicted measured between pegs 9 ft. 5 ins. in length and 4 ft. 5 ins. in height: an average male with much rubbed and worn horns of which the front horn is 7 ins. in length along the curve from base to tip.

R. sumatrensis spends most of its time in the heaviest forest it can find and only occasionally climbs onto the open grass-clad ridges and spurs which are a feature of the Sanctuary at elevations above 4000 feet.

There is still some hope that a specimen or two of the Lesser One-horned Rhinoceros (*R. sondaicus*), is to be found in the Shwe-u-daung Sanctuary. Tracks measuring 8½ ins. in diameter have been seen which correspond nearly to those of *R. sondaicus* in Mergui and Thaton in southernmost Burma. The tracks of the specimen of *R. sumatrensis* shot in this Sanctuary were a shade less than 8 ins., and I am afraid the animal responsible for the larger tracks will be found to be merely a larger specimen of the same species.

There appears to be no marked variation either in structure or habits between the specimen shot in the Shwe-u-daung Sanctuary and a couple of others shot by me about 8 years ago in the angle between the Uyu and Chindwin rivers. One of the latter was, however, a foot longer and 4 inches higher than the former.

Rhinoceros sumatrensis wander generally in pairs, and a former experience was duplicated in that the mate returned to the body of the one killed a few minutes after the shooting, and had to be driven off by a shot fired over her head. They appear to have a fair share of the pugnacity attributed to their African relatives, and are not the kind of animal one would care to meet at very close quarters when unarmed.

The Rhinoceros in the Sanctuary conform to the practices common to the species of making sometimes quite large collections of their droppings; wallowing frequently in liquid mud, and breaking down and twisting small saplings along the routes favoured by them. On one occasion I saw a small sapling that had, in some amazing manner, been twisted into a simple knot.

The protection afforded to the Sanctuary has taken the form of legislative rather than practical measures. There are no Game Keepers, unless one includes in this meaning the monthly visit of one or two foresters; no roads and no buildings. No signs of poaching were noticed either on the ridge or the lower ground at the wallows and licks. When one considers that a Rhinoceros is worth to the average poacher at least from 20 to 40 times his monthly income, the comparatively large number of Rhinoceros existing in the Sanctuary is a very great tribute to the law-abiding nature of the population surrounding the Sanctuary.

MAYMYO, E. H. PEACOCK.
February 15, 1931.

X.—BIRD MIGRATION NOTES FROM PORT BLAIR.

I have only very recently had access to Stuart Baker's completed edition of the *Birds of British India* and find that information is still required on many points to do with not only the rarer but even the common birds of the Andamans and Nicobars. I already knew that both the British Museum and the Bombay Natural History Society require skins of almost all birds from this region. I am myself leaving Port Blair before long but hope to find some resident here who will take up local ornithology and supply what is needed in the way of material as well as of information.

The Koel appears to be an immigrant. Which race have we got and what is its line of entry? In Port Blair, the Koel is first heard (but seldom seen) about October 7th, when he gives out short and timid notes about dusk as though to enquire whether any of his friends have also arrived and are lurking about. By December he and his wife are noisy and assertive. They seem to disappear in March. I have frequently visited the Nicobars in the second half of September and have found the Koel there well established as far as noise and bustle go. Is the line of migration through the Nicobars to the Andamans and if so is our race *malayana*? A comparison of female skins would settle the point. I have in much wandering only seen one male Koel after April. Perhaps it was a young bird without the migratory feeling. Every South-West monsoon there are a few Curlew, Whimbrel and

Eastern Golden Plover left behind and ornithologists in England have told me that this is common with immature birds.

There are also a few snipe to be flushed, very tame, in May and June and possibly these are the birds one shoots in early September. My shooting book shows that a few snipe are to be had in young rice during the middle of September and that there is often a period from about September 20th to October 20th when one may walk the most likely ground in vain. Then a favourable moon or some other weather factor brings the birds in thick. On the other hand in two seasons they have come in well about September 20th. Once arrived do they stay in Port Blair or move on elsewhere and make way for others? Generally the snipe grounds are pretty dry by December 15th and snipe hard to find. In 1926, however, 20 inches of rain fell between the 21st and 25th of December and the paddy stubbles in the east of the Settlement again filled with snipe and three weeks splendid shooting followed. Where did all these birds come from? Not from the western area which is later than the eastern but which could hardly have supplied so many snipe. Were they migrating birds passing over? This seems the more probable solution. What factors govern a good and a bad year for snipe? 1928-29 was good in Port Blair. On November 19th, 1928 another gun and myself got 50½ couple which is a local record. On the same day a year later, I walked the same ground, much of which was in prime condition, saw three snipe and killed one. It is to be remarked that in 1929-30 there arrived in Port Blair an immense number of Pale Harriers (*Circus macrourus* B. & O.). Every patch of rice had one of these birds over it. They also arrived in Stewart Sound, 90 miles North of Port Blair, some time in November and sat about on fences and trees in great numbers, apparently exhausted. Did they frighten away the snipe? The snipe season of 1930-31 was fair and there were no Pale Harriers about. But even in 1930-31 there was a complete absence of snipe in some places where in the past they have been very plentiful. Just at Christmas time, 1930, there were some 4 or 5 days of heavy rain and I looked forward to repeating the happy shoots achieved in January 1927 but the reconditioning of the ground was quite without effect and I walked over miles of attractive looking paddy swamp and hill side in January 1931 to find them completely devoid of birds.

On the night of the 24th of December after some days of high winds from the South-East a Petrel took refuge in the Settlement Mess from where I took it home quite unhurt sitting on my open palm. I left it for the night in a chart cupboard where it immediately got inside a rolled-up chart. Next morning when put on the table it at once took cover in a narrow crack left by me for the purpose in a pile of books, thus behaving as described on page 301, Birds, Volume vi, (new edition) *Fauna of British India*. The bird corresponded with the Dusky-vented Petrel, *Fregetta tropica melanogastra*, in measurements and colouration except that it had no white markings whatsoever, barring the extreme bases of certain feathers being white. I took the bird out on my hand after breakfast and as we encountered the South-East wind still blowing freshly it began to collect itself for flight and suddenly was gone, flying in a zigzag course into the teeth of the wind at great speed. While on a flat surface such as the table or when in my open hand it was strangely fearless, just gently mouthing at my finger if placed near its beak. A very interesting visitor.

PORT BLAIR,
ANDAMANS.

M. L. FERRAR, *Lieut.-Colonel,*
Chief Commissioner,
Andaman & Nicobar Islands.

XI.—THE INDIAN GREAT REED-WARBLER. [*ACROCEPHALUS STENTOREUS BRUNNESCENS* (JERDON)].

The recent discovery of the Great Reed-Warbler in the Mangroves of Rewas across the harbour from Bombay has led to a request from the Society that I should examine and report on the specimens of this species in their collection.

The Rewas specimen was collected by Mr. Salim Ali on the 2nd April, 1930, and he noted that the birds were noisy and numerous in the mangroves while the testes of the male were sufficiently large to suggest that the birds were at their breeding station. The question immediately arose therefore whether the birds belonged to the race *brunnescens* which breeds in Kashmir and westward to Transcaspia or to the race *amyæ* to which in the *Fauna* vol. ii, p. 390, the breeding colonies of the plains of India are attributed.

I have taken this opportunity therefore to go into the whole question of the status of these two races in India.

Three of these Great Reed-Warblers have been described from within our limits:—

Agrobates brunnescens Jerdon, *Madr. Jour. Lit. Sci.* vol. x, p. 269 (1839—Trichinopoly).

Calymodyta meridionalis Legge, *S.F.* vol. iii, p. 369 (1875—Ceylon).

Acrocephalus stentoreus amyæ Stuart Baker, *Bull., B.O.C.* xliii, p. 17 (1922—Hessemara, Assam).

The first name of course applies to the bird which has been so well known ever since Jerdon described it nearly a century ago and which ornithologists in India for many years considered could only be a winter visitor to India though it was known to breed in Kashmir.

The other two names owe their existence to this belief in *brunnescens* as a winter visitor. Legge discovered that a Great Reed-Warbler bred and was resident in Ceylon and jumping to the conclusion that it could not therefore be the same bird as the winter visitor separated and named it on differences which Hume immediately shewed to be non-existent.[1]

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[1] Wait (Birds of Ceylon) is inclined to believe that the breeding form of Ceylon should be called *amyæ*. But if the Assam and the Ceylon birds were the same and were separable from *brunnescens* both would be called *meridionalis* by the rule of priority.

Then when several zoologists discovered that a Great Reed-Warbler bred in the Gangetic plain history repeated itself and *amyæ* was separated and named on distinctions, which I shall show, no more hold good than those of *meridionalis.*

Turning to the original description we find that *amyæ* is there described:—"A small dark form of Reed-Warbler, similar to *A. s. brunnescens,* but decidedly smaller and darker. In this race of *A. stentoreus* the under surface is darker and more richly coloured than *A. s. brunnescens,* and so marked is this that breeding birds of the new race in breeding plumage are darker even than winter specimens of that bird."

Disregarding the point that the worn breeding plumage of a Great Reed-Warbler is usually darker in tone than fresh winter specimens—had the fact been the other way round it would have been of importance—there is one serious objection that this race has been named on a single specimen. The type cited is ♂ no. 12-4-05. Stevens, Coll. no. 2650 and it is now in the British Museum. This bird is referred to in *J. B. N. H. S.* xxiii, 247 as follows:—"Secured in heavy reed jungle at evening, single record only." At the time there was no reason to believe it a breeding bird at all. Later on however, when Mr. Stevens was, as he says (*J. B. N. H. S.*, xxix, 1015), examining his Assam collection afresh it became evident that the eggs of Reed-Warblers obtained on the "Churs" of the Subansiri river belonged to two forms, a large and a small. As skins of two species, a large and a small, had been obtained (though only one of the latter had been actually shot upon eggs) it was assumed that the eggs belonged to the two species in question. As *brunnescens* is found as a migrant well into May it is obvious that there is not any necessary connection between this April bird (of which the organs are not recorded as in breeding condition) and eggs found in the local reed beds.

This single bird I cannot separate in any way from *brunnescens.* In colour, I can exactly match it with a Kashmir breeding bird, whilst in size I can match it with many specimens of *brunnescens.*

In the description, its wing is given as 81·5 mm. Mr. Stevens himself (*loc. cit.*) credited it with a wing of 83 mm. I personally measured it as 83·5 and that was independently verified for me by Mr. Kinnear in ignorance of my result.

A. s. amyæ must therefore be considered as a synonym of *A. s. brunnescens.*

In the course of my enquiry I took the opportunity to collate the records of *A. s. brunnescens* for our area and to go carefully through all available specimens. It may be of interest to put the results on record.

The first point that has emerged is that the Great Reed-Warbler is far more widely spread as a breeding bird than the *Fauna* recognises. *Brunnescens* is said (*Fauna,* ii. 389-390) to breed in Kashmir and Garhwal whilst Bahraich, Gonda and Assam are given for *amyæ.*

I find however, the following records, working from west to east within our limits. In British Baluchistan, it breeds at the Kushdil

Khan Lake, on the Lora River and near Quetta (*J. B. N. H. S.*, xxxi, 696), in Sind on the E. Narra (*Ibis*, 1922, 548), in the N.-W. F. Province near Dundar in the Kurram (*Ibis*, 1909, 119) and possibly in the Kaghan Valley (*J. B. N. H. S.*, xxiii, 104). In the Vale of Kashmir it of course breeds in immense numbers. In Gurdaspur district there is a huge breeding colony on the Kershopin jheel (*J. B. N. H. S.*, xxiv, 602.) The authority for the statement that it breeds in Gharwal I have not found.

From here there is a gap in the records, but specimens in the British Museum from Delhi (Bingham, 1st August), Moradabad (June, Hume Coll.), and Theenguik (13th September, Brooks) all in worn breeding plumage, and Loyah Bridge (18th October, Hume Coll.) completing an entire moult all suggest local, breeding colonies. Be that as it may colonies are recorded from Bahraich (*J. B. N. H. S.*, xxviii, 755) and Gorakpur (*J.B.N.H.S.*, xxii, 535).

The evidence for the supposed colony on the Sabansiri River, N. Lakhimpur, has already been discussed. There is then a definite gap until we reach the Southern Shan States where eggs have been procured at Taungwhe (Wickham, *J. B. N. H. S.*, xxxiii, 824) and Inle Lake, Yaungwhe (Livesey).

Southwards there is no definite record until Ceylon is reached but Davidson (*S. F.* x, 307) thought that there was probably a breeding colony on the Tapti below Prakasha in W. Khandesh and Mr. Salim Ali's bird is very suggestive. Its organs on the 2nd April were far larger than those of migrants I have collected in May in the Punjab. That mangrove swamps suit the bird for breeding is known on the Mekran Coast and they probably nest in the mangroves of Karachi also.

It is unfortunate that the egg collectors who recorded the above nesting colonies did not trouble to collect a series of skins to verify their discoveries. Field preserved two birds at Gonda which are now in my collection. His nests were taken in May and June and again in July and August. So the male shot in August is doubtless a breeding bird. It has a wing of 79 but is terribly worn. The other bird (♂ wing 84·5) was shot in March so does not necessarily but probably represents the breeding colony. An unsexed bird shot by him, also in March, in Bahraich has a wing of 84 mm.

Legge's two males from Ceylon (*S. F.* i, 488) on the other hand have each a wing of 86 mm., the Delhi, Moradabad and Theenguik birds mentioned above have wings of 93, 90, and 87 mm. (♀, ♂ ♂). The moulting wing of the Loyah bird does not admit of measurement.

Six males collected by me from the Kashmir colony measure 88-92 mm. I can see no difference in colour, except such as is due to abrasion, between Kashmir and plains birds, whilst the measurements quoted do not permit of any separation between the Kashmir and the Indian birds on size. A large series of measurements taken from non-breeding birds in India, on migration or in winter gives a variation in wing length from 79 to 93 for both sexes.

It is evident that we have no reason at present to separate the plains' bird from the Himalayan. I am not prepared to accept as a reason the small measurements of a small series of eggs, or the statement that the nests looked small, more especially bearing in mind my warning (*Ibis* 1928, 451), that *Acrocephalus agricola* will probably prove to be a breeding bird of the Indo-Gangetic Plain.

It is not impossible, however, that the Great Reed-Warblers which breed in the Southern Shan States may prove to be separable. There are three specimens available in the British Museum:—♂ 24-4-25 Taunggyi, ♂ 10-3-29, ♀ 22-3-29 Yaungwhe with wings respectively 81·5, 84, and 83·5. The Taungyi bird would pass in colour as a Kashmir specimen. The other two are very close, but are perhaps darker, a more saturated colour above and a greyer, less fulvous-brown below. Should further breeding specimens confirm this difference separation will be possible.

It is difficult to define the status of the Indian Great Reed-Warbler very accurately. Like all jheel birds its movements are affected by the quantity of rain in any given year and by the burning and the cutting of the reed beds. Few observers have taken the trouble to record its status in their particular locality. It is at any rate established that whilst in parts of India the bird is a resident or a local migrant there is a great influx of winter visitors from Kashmir and the extralimital breeding range away to Transcaspia.

These birds can only be recognized from the records when they pour through the North-west on spring and autumn passage. Thus:—Kohat, 'common on migration from the end of March till well into June and again in August and in September' (Whitehead, *Ibis,* 1909, 119). Baluchistan, 'It is most noticeable on passage at the end of August and September and is apparently absent until April' (Ticehurst, *J. B. N. H. S.,* xxxi, 696). Karachi, Sind, 'passage migrants may be seen from the first week in September onwards ... they pass through again from mid-April, and the latest I have seen them is the 2nd May' (Ticehurst, *Ibis,* 1922, 549). These records could be further substantiated by a nuumber of others, but it is unnecessary to labour the point, beyond remarking that on passage the Great Reed-Warbler is found anywhere, in crops, trees and hedgerows and gardens and is then not confined to the reed beds.

The breeding season in Kashmir, Baluchistan and India is from May to August.

Calbec House,
Battle, England.
May 1931.

HUGH WHISTLER.

[Mr. Salim Ali sends us the following extracts from his diary and states he is almost certain that the birds breed in the tidal mangrove swamp that flanks the neighbourhood of Rewas Pier and extends along the Dharamtar Creek. He made several attempts last year to procure nests and eggs from this locality, but owing to the nature of the terrain and density of the growth was unsuccessful. Even offers of *bakhsheesh* were unable to tempt the local fisherfolk to search for them.

April 1, 1926: Numbers present in the mangroves about the pier, calling in loud harsh notes from the tops of the bushes.

May 15, 1926: Still present in the mangroves. Its voice appears out of all proportion to its size. It is a great ventriloquist. I should not be surprised if a breeding race is found in this part of India.

April 2, 1930: Shot specimen while warbling from top of mangrove bush. Male*. Testes greatly enlarged: W. 84, Bill 19, Tar. 28 mm. Numerous in mangroves and noisy.

May 31, 1930: Still present; plentiful and noisy.

June 26, 1930: Still present; Males clambering up to exposed branches and warbling.

July 8, 1930: Seen and heard. I am sure it *must* breed in the mangroves.

Aug. 2, 1930: Still present. Warbling vociferously.

Aug. 8, 1930: ,, ,,

Sept. 7, 1930: ,, ,,

Sept. 28, 1930: ,, ,,

Oct. 4 & 8, 1930: ,, ,,

Decem. 20, 1930: ,, ,,

March 20, 1931: Present in the mangroves. Warbling.

May 10, 1931: ,, ,,

May 28, 1931: ,, ,,

In addition to the above, Mr. Ali also observed the birds among the mangroves at Mahul (Trombay Island) on the 6th May 1931, and remarks that the males were exhibiting the same excited and noisy behaviour. Eds.].

XII.—COMMENT ON THE OCCURRENCE OF THE GREY HYPOCOLIUS (*HYPOCOLIUS AMPELINUS*) IN INDIA.

In the last number of the *Journal* (Vol. xxxiv, 1061), Mr. Salim A. Ali records the shooting of *Hypocolius ampelinus* and states that its occurrence in India seems to have been recorded only once before. Presumably he refers to the bird obtained by Blanford (Barnes' *Birds of Bombay*, p. 149).

In the cold weather of 1900-1901 I shot a specimen on the Gadaf Plain near Karachi and sent it to the Karachi Museum where it was skinned.

Further I sent a notice of this to the Bombay Natural History Society's Journal but as the notice was not printed apparently the matter did not seem worthy of record.

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* This is the specimen referred to by Mr. Whistler in his note

As to Mr. Ali's letter about the casualties among the young of small birds perhaps pp. 164 and 165, Grey's *Charm of Birds* might interest him. There is put forward the view that the visits of a man to a nest help to show the nest to the robbers.

21, Northmoor Road, PERCY HIDE.
Oxford.
April 5, 1931.

[On page 544 of his paper on the Birds of Sind (*Ibis*, July 1922) Dr. C. B. Ticehurst omits mention of the specimen procured by Mr. Hide. Evidently the skin no longer existed in the Karachi Museum when Dr. Ticehurst examined its ornithological collections. It is unfortunate that the occurrence of this rare bird within our limits should have escaped record in the Journal. Eds.].

XIII.—THE MAGPIE ROBIN (*COPSYCHUS SAULARIS*, LINN.) IN NORTH GUJARAT.

On page 84 of his *Popular Handbook of Indian Birds* Mr. Hugh Whistler writes: "Although said to be only a winter visitor to Mount Abu and Northern Guzerat, ... etc.", I do not know who started this idea but it has absolutely no truth in it as the Magpie Robin is found in this district all the year round as will appear from the under-noted observations which I quote from my diary. The mistake seems to have been made by some official who in the hot season had failed to observe the presence of the bird because he himself retired to a hill station or because the bird left his usual haunts in the breeding season to build its nest in some secluded place. Otherwise it is impossible to ignore the Magpie Robin in summer as they are met with in all sorts of places and are found singing at all hours in the day.

My observations will show the occurrence of the bird in various places in and around the city of Ahmedabad in North Gujarat.

Aug. 31, 1930: Saw a ♂ flying in and out of a lime tree in Shahi Bag.

Sept. 2, 1930: In a neem tree near Grand Hotel, a single ♂.

Oct. 2, 1930: In a bamboo clump near Gujarat College, a ♂.

Nov. 6, 1930: A couple under a bush on way to Ashlali, five miles South of Ahmedabad.

Jan. 1, 1931: Found a ♀ living in a bamboo clump in a private garden outside Delhi Gate. For about two months, I saw this bird daily at about 8-30 a.m. basking in the morning sun, perched on a branch. It disappeared in the last week of February. It was also observed in the afternoon at intervals. I never heard her utter a note.

Feb. 5, 1931: I got a couple of ♀ birds for my aviary. They were caught near the Sabarmati Station (B.B. & C.I. Ry.). Ultimately I had to free them as they did not thrive in captivity.

March 15, 1931 : Got another pair (this time a ♀ and a ♂). They were freed after a week's trial.

April 30, 1931 : Saw a ♀ bird feeding on ground in an alley near my house in the heart of the city.

May 2-28, 1931 : A pair built their nest near my house. I saw them every day—sometimes together, at other times singly—feeding on the ground in the company of Indian Robins (whom the magpie ♂ chases away at times), mynahs, house sparrows or warblers. Every morning, taking its perch at the highest point of a house nearby, the male sends forth its beautiful music, whose liquid notes float softly in the cool morning air. This is their breeding time and they do not seem to tire of their singing which continues throughout the day. At the time of writing this note, the ♂ is singing lustily on the roof of a house in front of my window. They have apparently laid their clutch in some hole in this locality though I have not been able to locate it. The birds are very shy, though the ♂ seems to be the bolder of the two. The ♀ is generally accompanied by the ♂ who shifts his perch every few minutes.

May 16, 1931 : Saw a ♂ singing from his perch on the telephone wires in front of the Municipal building. No amount of din created by the hooting and purring of passing motor cars could interfere with his song which was poured out without a break.

May 26, 1931 : Heard a ♂ singing on the outskirts of Asarva, a suburb.

May 27, 1931 : Saw a ♂ in a tree in the compound of the Mahalaxmi Training College for Females.

I have found that the song of the Magpie Robin has two distinct groups of notes. Generally it has 9 to 10 notes: 2+4+3 or 4. But the bird in front of the Municipal offices had quite different notes: *tirtu—tirtu—tirtutu* (which I confess is a poor attempt at imitation). The difference was clear and unmistakable, as I had waited for about five minutes under the bird and the song was distinctly heard. At times I have found the ♂ (watching from a roof the ♀ feeding on the ground) utter some soft whistling notes which are very pleasing though indistinct.

AHMEDABAD, HARI NARAYAN ACHARYA.
(NORTH GUJARAT.).
May 28, 1931.

XIV.—THE MIGRATION OF THE ROSY PASTOR (*PASTOR ROSEUS* L.).

Through the kindness of Dr. J. Schenk of the Royal Hungarian Institute of Ornithology, Budapest, I have obtained a most interesting record of the recovery in India of a specimen of the Rosy Pastor which was marked as a nestling in Hungary. The particulars of this bird are as follows:

Date of Ringing: 30 June, 1925.

No. of Ring: 27381 (of the Royal Hungarian Inst. of Ornith.).

Locality: Village Novaj, N.-E. Hungary, 47° 55′ N. Lat. × 20° 30′ E. Long.

Date of Recovery: 28 April, 1926.

Place of Recovery: Lahore (Punjab) 31° 35′ N. Lat. × 74° 20′ E. Long.

The recovery was reported by Mr. M. J. Sheikh, proprietor of "Karachi Motor Works", Lahore, who kept the bird alive for a fortnight before it died of its wounds. Mr. Sheikh further informs me that the ringed bird was amongst a lot of twenty that fell to a single shot of his, at a place about four miles out of Lahore City. According to him the birds are plentiful in this locality between 10th April and 15th May, during which time they feed largely on "Badana" (?) berries and grow very fat, and are eagerly sought after as food. The direct air distance between the places of marking and recovery in this case is 3000 miles.

From an excellent paper on the Rosy Pastor in Uzbekistan (Turkestan) recently published in the *Journal für Ornithologie*[1] we learn that the author ringed 1,000 nestlings in 1929 and another 2000 in 1930 in that locality. The 1929 rings are 1 centimeter broad and all fastened on the right legs of the birds. They bear the inscription "UZ" in addition to the serial number. The 1930 rings belong to the Moskow Biological Station, numbers 11201-13200, and besides the serial number and the cipher F (denoting the series) they are inscribed "Moskwa-Bjun". It is very probable that some of these marked birds may be recovered in India, in which case it is requested that the person finding it, or whoever comes to hear of it, should send the information with particulars as regards number and inscription on ring, date, locality etc. to the Bombay Natural History Society who will communicate with the ringers concerned. If possible, the leg of the bird with the ring attached should also be kindly forwarded.

KIHIM,
KOLABA DISTRICT.
March 7, 1931.

SALIM A. ALI.

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[1] Serebrennikov, M. K., 'Der Rosenstar (*Pastor roseus* L.), seine Lebensweise und ökonomische Bedeutung in Uzbekistan' Turkestan), *Jour. für Ornithologie*, lxxix, 1, pp. 29-56, Jan. 1931.

XV.—OCCURRENCE OF THE SIND RED-WINGED BUSH-LARK (*MIRAFRA ERYTHROPTERA SINDIANUS*) IN THE RAWALPINDI DISTRICT OF THE PUNJAB.

On the 16th October last I shot a juvenile Red-winged Bush-Lark (*M. erythroptera sindianus*) in the scrub-covered foot-hills at Kallar, some 20 miles from Rawalpindi, and in the following February obtained a pair of adults in the same locality. The specimens have been identified by Mr. H. Whistler, who informs me that this is an extension of the range of the bird which is worthy of record.

Rawalpindi,
Punjab.
April 26, 1931.

H. W. WAITE,
Indian Police.

XVI.—ELEVEN KOEL EGGS IN A CROW'S NEST.

On 9th June I came upon a Common Crow's nest (*Corvus splendens*) at Bhandup (Salsette) containing eleven Koel (*Eudynamis scolopaceus*) eggs belonging to two distinct types and apparently the product of two females. There were four eggs of one type and seven of the other. I removed one egg of each type which were kindly confirmed by the Society as having been laid probably by different females. The nest contained no crow eggs, but bore obvious signs of having recently had an egg broken in it. As far as could be ascertained the locality certainly appeared to hold more koels than crows, a circumstance which may account for the concentration on this nest.

On the 17th I visited the place again to find the nest empty! There was another nest within 50 yards—not previously noticed—in which a crow was sitting.

Andheri,
Salsette.
June 20, 1931.

HUMAYUN ABDULALI.

XVII.—THE OCCURRENCE OF PIED CRESTED CUCKOO (*CLAMATOR JACOBINUS*, BODDAERT) IN NORTH GUJARAT.

Mr. Hugh Whistler in a recent number of the Society's *Journal* writes: The Pied Crested Cuckoo is a rainy season visitor and is spotted in Gujarat as under:

Deesa: Plenty in July.
,, : May 25 to October 20.
Anandra (Near Abu): July 5.
Rajkot (Kathiawar): June 5.

In this connexion the following observations made by me last year around Ahmedabad will be found interesting:—

June 6, 1930:	Saw a pair on a Peepal tree near Ashlali, six miles south of Ahmedabad.
Nov. 6, 1930:	A single bird in a Neem tree in the same locality.
Oct. 15, 1930:	A young bird was observed in Bhavnagar (Kathiawar).

Between June and November, I came across the birds occasionally. They do not seem to visit this district in large numbers as the maximum I saw at any time was three.

AHMEDABAD, HARI NARAYAN ACHARYA.
(NORTH GUJARAT).
May 23, 1931.

XVIII.—THE MIGRATION OF THE WHITE STORK (*CICONIA CICONIA*).

On the 2nd December, 1930, the leg of a stork was found in a dried up condition at the edge of a small lake in Bikanir, Rajputana and forwarded to us by Capt. Maraj Kumar Shri Sadul Singhi Bahadur. The leg had a numbered ring put on through the agency of the Ornithological Station, Heligoland. The recovery was reported to Dr. R. Drost, the Director, who in reply informed us that the bird in question, a young White Stork, was ringed on the 11th June, 1930, near Braunschweig, Germany (*ca* 52·16 N. Lat., 10·30 E. Long).

BOMBAY NATURAL HISTORY SOCIETY, S. H. PRATER.
July 15, 1931. *Curator.*

XIX.—OCCURRENCE OF THE FALCATED TEAL (*EUNETTA FALCATA*) IN THE JHELUM DISTRICT.

It may be of interest to your members to know that I shot a drake of the Falcated Teal (*Eunetta falcata*) at Chomud near Chimainsala Battlefield, about forty miles from Jhelum in February last year. Captain Johnson of my regiment can vouch for the occurrence. The bird was in full plumage with the sickle-shaped secondaries fully developed. I intended at the time to forward the bird to you, but was unfortunately shooting for several days and on my return found that the Mess 'khansamah' had got hold of and plucked the bird in error. However, there could be no possible mistake over the identification, the specimen I shot was marked in every detail in accordance with Stuart Baker's illustration and though I had never seen the bird before, I was able to recognize it off-hand on the spot before I returned and turned up the book,...

I was so disappointed over the loss of the skin that I did not report the fact at the time and allowed it to elapse until Mr. Hopkinson recently persuaded me to do so.

If you are interested enough and would like further data, Mr. Wilson, R.E., of Roorki whom I met coming out to India this year, told me, in a chance shikar talk, that he had also shot and identified the bird on one occasion near Roorki last year.

JHELUM.
March 24, 1931.

M. C. FRYE,
Captain,
1st Bn. 1st Punjab Regiment.

XX.—THE WHITE-FRONTED GOOSE (*A. ALBIFRONS*) IN MANIPUR.

In addition to the Eastern Grey Duck reported to you in another letter, the following locally scarce birds have been shot this year:—

White-fronted Goose (*Anser albifrons*)—One shot on January 18, 1931, by Colonel M. Goodall: this is the fourth specimen recorded in the Manipur Club Game-book, which has been kept since 1910.

Eastern Solitary Snipe (*Gallinago solitaria*)—One shot by me on February 7, 1931: this is the third specimen recorded since 1910.

THE RESIDENCY,
IMPHAL, MANIPUR STATE.

J. C. HIGGINS,
I.C.S.

XXI.—ON THE DISTRIBUTION OF THE EASTERN GREY DUCK (*ANAS ZONORYNCHA*).

I was surprised to read, in Mr. Inglis' letter in Vol. xxxiv, 3 of the *Journal*, the statement that a drake of the Eastern Grey Duck (*Anas zonorhyncha*), shot in Darbhanga in March, 1929, was the first Indian record of this species excluding two specimens shot in Burma. Mr. E. C. Stuart Baker, in *Indian Ducks and their Allies*, says:—

'In 1902, Messrs. Moore and Mundy got several specimens in Dibrugarh, and each succeeding year up to 1905 got others. I obtained my first specimens in 1903, and got a good many more in 1904 and 1905.'

On the 28th December, 1908, Messrs. Botham, McKercher, Burke, Hay and I obtained 3 on a small *bhil* in the Sibsagar district.

What has always surprised me in view of these comparatively plentiful records from the Assam Valley, is the fact that this species has never been recorded from the Manipur Valley, until recently, although the Spotbill (*Anas pœcilorhyncha*) is resident there, and is far commoner than in the Assam Valley. Between 1910 and 1931, the Manipur Club game-book records 3437 *pœcilorhyncha.* I have been present when 2265 of these were shot, and have personally examined the majority of these, as I have always been on the lookout for *zonorhyncha.* But I have only seen 2 *zonorhyncha*—one shot by Colonel Goodall on February 6th, 1930, and one by me on January 18th, 1931.

The Eastern White-eye (*Nyroca baeri*) to which Mr. Inglis also refers in his letter, is a fairly regular visitor here. It was first recorded in the Club game-book in 1912-13, since when 48 have been shot.

THE RESIDENCY, J. C. HIGGINS,
IMPHAL, MANIPUR STATE. *I.C.S.*
March 18, 1931.

XXII.—NOTES ON THE MIGRATION OF BIRDS IN THE NORTH-WEST FRONTIER PROVINCE.

The following notes on the migration of birds may be of interest to you:—

Kohat:

Demoiselle Crane. *Anthropoides virgo.* 27th August, 1928, 27th August, 1929, 25th August, 1930.

(Noted coming into India from the North-west.)

An Officer in the Mess asserted that he always hears the first *Kullam* on his birthday—27th August.

Rosy Pastor.	*Pastor roseus*	July 25, 1930.
The Raven.	*Corvus corax*	August 1, 1930.
'Teal'	... ...	September 7, 1930.

In 1930 the exit of migrants from India was much delayed—Snipe and Teal were still to be found in the Kohat District as late as 1st. May. It was an exceptional year so much so that flowers normally coming out in September bloomed in April and the Chrysanthemums came into bud and flowered here then, their normal season being November to December.

KOHAT, G. de la P. BERESFORD,
N.-W.F.P. *Lt.-Colonel*, M.C.
7-12-1930.

XXIII.—CONGENITAL ABSENCE OF A FORE-LIMB IN A BULL FROG (*RANA TIGRINA*).

(*With two photos.*)

During the monsoon of 1930 a collection of frogs and toads from Thana was made by the Pharmacological Department of the G. S. Medical College, Bombay. One of the specimens showed the absence of a left fore-limb. Later on the specimen was transferred to the Embryology Department of the same College.

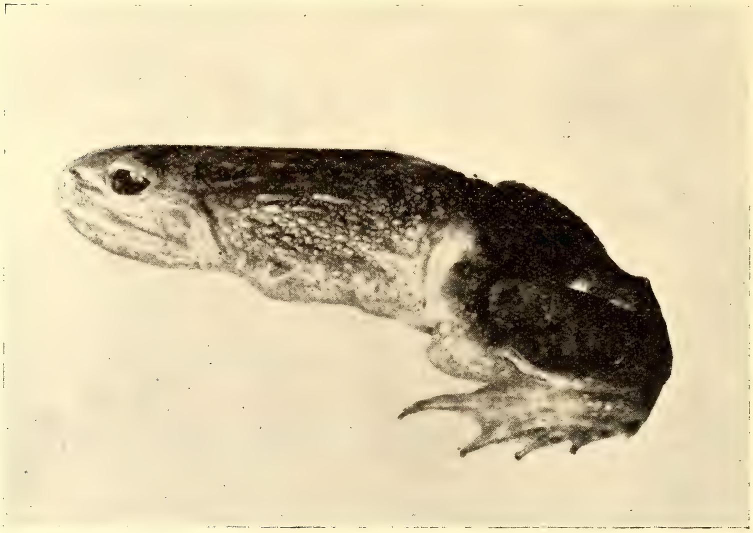


Fig. A. *Rana tigrina* lateral view.

The sitting posture of the animal was very queer (Fig. A.). The surface where there was the absence of the arm presented no mark of any kind, and the skin, colour, and the contour of that region was just like that of the surroundings (Figs. A. and B.). Fig. A. shows the dorsal view of the specimen and Fig. B. the left lateral view of the same.

The absence of the limb does not seem to have affected in any way the normal development of the frog, and obviously it could get its food without much difficulty.

On dissection, the following peculiarities were noticed. The pectoral girdle of the right side was fully developed while the supra-scapula alone represented the pectoral girdle of the left side; the scapula, the coracoid, and the clavicle being completely absent.

Instead the pectoral muscles were greatly developed and they took their origin from epicoracoid region and were inserted into the inner concavity of the supra-scapula.

In the arterial system, the subclavian or branchial artery was found to be absent.

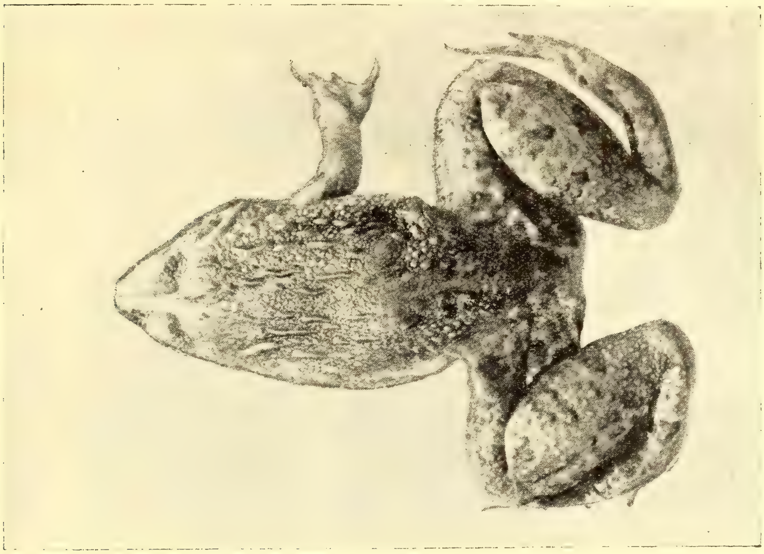


FIG. B. *Rana tigrina* dorsal view.

The subscapular from the back of the arm and the branchial from the arm of the left side were absent.

All the nerves which in ordinary condition used to arise from the brachial plexus were found to be in a rudimentary condition on the left side while, on the right side, all the nerves were found to be normally developed.

DEPARTMENT OF EMBRYOLOGY,
GOCULDAS SOONDERDAS COLLEGE,
BOMBAY.

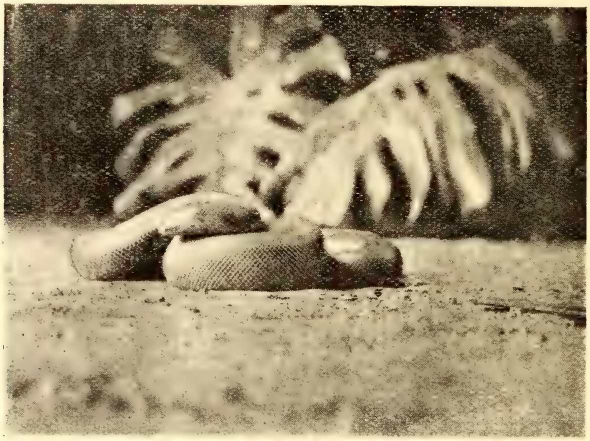
G. M. KURULKAR,
D. S. DESHPANDE.

XXIV.—THE COLOURATION OF THE TAIL OF THE COMMON SKINK (*LYGOSOMA PUNCTATUM.*)

(*With a photograph.*)

A friend of mine recently asked me why the tail of the common skink of these parts (*Lygosoma punctatum*) is red, while the rest of the body is brown or olive above. The cause, of such peculiar coloration, though not mentioned so far, is not hard to seek. The tail of the skink, like that of the house-lizard (*Hemi-*

dactylus flavivirides), is fragile and serves as a device for defence. When the creature is attacked, the tail breaks away from the body and begins to perform a series of convulsive movements, jumping and twisting as if in great pain and thereby diverting the enemy's attention from the escaping tail-less trickster. The red color makes the tail prominent and increases its efficiency.



The Sand Boa (*Eryx johnii*).
(Note the head-like tail).

Nor is it only in the skinks and the house-lizards that the tail has taken on itself the task of deceiving the attacker. Amongst others, the case of the common Sand Boa of Agra (*Eryx johnii*) might be mentioned. Here the stumpy, bluntly-rounded tail looks so much like the head that the snake has been given the name '*Dumuhi*' (the 'two-headed' in Hindustani). The snake-charmers of India have spread a great many lies on this point, and there are people who believe that this Sand Boa, after using one end of its body as the head for six months, gives that honor to the other end and drags the former head behind it as the tail. Really the tail of the sand snake is a tricky device for defence. When attacked, the sand snake tries at first to escape, but if it finds such efforts futile, it coils itself tightly, keeping the head below the coils, and making the tail jut out at some prominent point (see photograph). The tail by its appearance diverts attention from the actual head.

ST. JOHN'S COLLEGE, AGRA.
March 30, 1931.

BENI CHARAN MAHENDRA,
Lecturer in Zoology.

[The red colouring of the end of the tail may in some skinks be a condition dependent on age. The young of the common skink (*Mabuia carinata*) frequently have the extremities of the tails coloured red, this disappears with age. The same character is displayed by the American Blue-tailed skink. In the young the tail is bright blue; as the skink grows older the colour fades to grey. In the skink referred to in the above note the red persists throughout life. Mr. Mahendra's interpretation of the red colouring of its tail as a defensive adaptation provides an interesting contrast to the theory which explains the red end of the tail of certain Vipers as a medium of offence. Young examples of the Green Pit Viper (*T. gramineus*) and of the Large-scaled Viper (*T. macrolepis*), uniformly green snakes, often have the ends of their tails coloured red. It is suggested that the dash of brilliant colour attracts small birds, lizards and frogs. Coiled among vegetation the green coloured owner of the red-tipped tail is practically invisible.

The tail of the Sand Boa (*Eryx johnii*) is again believed to be useful to the reptile in overcoming its prey. In our desert regions, where this snake is common, it is generally seen half buried in the sand with its stump-like tail projecting like some forlorn root. A gerbille or field mouse brushes against or inspects the stump. The snake is galvanised into activity, leaping from the sand it flings its coils about the rodent and holds it in a vice-like grip. EDS.].

XXV.—NUMBER OF VENTRAL SCALES IN THE FASCIOLATED DHAMAN (*Z. FASCIOLATUS*).

Boulenger in an old edition of *Reptilia of India* states that *Zamenis fasciolatus* has 197-225 ventrals, 73-88 subcaudals. He does not mention the Bombay Presidency as a habitat for the snakes recorded by him. Wall mentions:—ventrals, 191-232, subcaudals, 73-92. The four specimens secured by me, three from Ahmednagar and one from Vizapur have;—

(1) Ventrals 228, subcaudals 61. Length of snake 4ft. 8 ins. A note was published in your journal about this specimen.
(2) Ventrals 232, subcaudals 37. Length of snake 4 ft. 6 ins.
(3) Ventrals 240, subcaudals 87. Length of snake about 18 ins. This specimen was sent to me from Vizapur.
(4) Ventrals 232, subcaudals 50. This specimen was sent to you lately.

So it seems that the range of ventrals will have to be increased to 240 and of the subcaudals lowered to 37 unless this type is considered a variety.

AHMEDNAGAR.
26-6-1931.

K. G. GHARPUREY,
Lt.-Colonel, I.M.S.

XXVI.—DETERMINING THE AGE OF INDIAN FISHES FROM THEIR SCALES.

The methods for determining the age and the rate of growth of fish by an examination of scales, otoliths etc. have not so far been attempted in India, neither have the scales of Indian fish ever been subjected to a critical examination. As the result of an extended observation of fish scales from different parts of India, I have come to the conclusion that the scales from Indian fish no doubt present very great difficulties inasmuch as the rings on these are not well marked. This feature introduces peculiar difficulties which greatly handicap their elucidation. I have, however, come across some scales on which by the graphical method evolved by Winge, one could pick out what would appear to be distinct growth rings but one should hesitate a good deal before accepting them as age rings.

In India as elsewhere each species of fish must be investigated by the methods which one can best apply to it. What holds good in one species is not necessarily applicable to another, and apart from this even a specialist on scales from English fish would not venture to pronounce any definite opinion with regard to the interpretation of Indian scales. Even when one has specialised in reading the scales of one species of fish, it does not follow that he is quite qualified for applying the same principles to other species, as for instance a Salmon scale specialist in England is not the most competent person to advance an opinion on Trout scales.

To be able to say anything definite, one must examine as many fish of one species as possible in detail, carry out systematic measurements of rings to discover their interpretation. I feel we have ample material for age and growth studies of fish in India.

ROYAL INSTITUTE OF SCIENCE,
BOMBAY.
June 10, 1931.

S. B. SETNA,
M.Sc. Ph.D.

XXVII.—NOTES ON THE BEETLE *PLATYPRIA ECHIDNA*, GUER.

On the 10th of May I found a large number of these beetles congregated under the leaves of *Zizyphus rugosa*, Lamk. at Khandala. On examination of the leaves, it was discovered that the beetles were feeding on the epidermis of the upper side. So far as I am aware this plant is not known to constitute the food of these insects. *Platypria erinaceus*, F. is said to have been found on a species of *Zizyphus* at Belgaum. *Platypria andrewesi*, Ws. was taken on *Zizyphus jujuba*, at Nagpur and on a species of *Zizyphus* at Hajari. It was also obtained on sugar-cane leaves. *P. hystrix*, F. was taken on *Erythrina indica* at Madulsima, Ceylon. Thus we see that the majority of the genus, so far as is known, have been taken largely on species of *Zizyphus*.

When touched these beetles dropped vertically to the ground (as is the habit of many insects) and tried to hide themselves in the fallen leaves. Some of them took to flight when they reached the ground.

On the 29th May I came across many more specimens of the same species (*P. echidna*) on the same food plant (*Z. rugosa*). At this period I also found a few in copulation.

Bombay Natural History Society,
6 Apollo Street, Bombay.

C. McCANN, F.L.S.,
Asst. Curator.

XXVIII.—ON THE FERTILIZATION OF THE FLOWERS OF THE SAUSAGE TREE (*KIGELIA PINNATA*, DC.) BY BATS.

(*With 3 diagrams.*)

My observations on the opening time of the flowers of the Sausage Tree (*Kigelia pinnata*, DC.) soon brought me to the conclusion that the flowers are nocturnal. They open in the evening usually between 5-30 and sunset and by about 9 a.m. the next morning, provided the flowers have been fertilized, all the corollas drop to the ground leaving only the calyx and style in position. When fertilization has not been effected the entire flower falls away from the articulation immediately below the calyx. The corollas—deep blood- or wine-red within, and yellowish-green on the outside—are large and fleshy with many wrinkles and furrows. When open, the flowers emit a strong and somewhat unpleasant odour. The four stamens are placed in the manner characteristic of the order *Bignoniaceæ*, to which this species belongs. The bases of the filaments are much thickened and are densely papillose within the throat of the flower; together with the style, these swollen bases fill up the entrance to the throat. The style is long, tapering from the base upwards; it is somewhat recurved and exerted beyond the corolla. The stigma is bifid and appears like two leaf-like structures at the extremity of the style. At the base of the ovary are situated several large nectar glands which secrete a copious

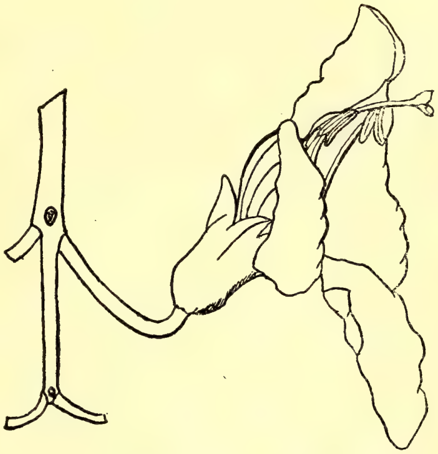


Fig. 1. Position of flower of *Kigelia pinnata*. (Half nat. size).

amount of clear sweetish nectar. This liquid fills up the cavity between the nectaries and the throat of the flower and trickles out into the furrows of the lower petal when the flower is bent downwards.

It appears curious that such a deep-red coloured flower should be adapted for nocturnal fertilization. In passing, it might be mentioned however, that similarly dark-coloured flowers also nocturnal in habit has been observed by me in the case of *Oroxylum indicum*, Vent. a common species on the island of Salsette, and belonging to the same natural order. In this case also I find that the flowers only open in the evening and are shed by the next morning, making it next to impossible to obtain a photograph of the tree in flower without the aid of a flashlight. On the other hand, I consider it noteworthy that *Heterophragma Roxburghii*. DC. and *Stereospermum xylocarpum*, Wight, also belonging to the same order and both fairly common in the same locality (Salsette) have creamy-white flowers ("night-coloured") which open only during the daylight hours ! It was not until I accidentally observed a bat visiting one of the Kigelia flowers that I was led to investigate the matter further. Many of the *Bignoniaceæ* are said to be fertilized through the agency of birds, though in the case of a species like *Oroxylum indicum*, Vent. this process appears to me hardly applicable since most birds are already on their way to roost by the time the flowers open. An examination of the Kigelia flowers which opened early in the evening showed that the anthers were not yet ready to disperse their pollen, whereas those examined at dusk had the anthers perfectly ripe and the pollen ready for despersal. The slightest jerk to the flower caused the pollen to drop down directly on to the lower petal. The fact, therefore, of the pollen only becoming ready for dispersal at dusk does away with the possibility of fertilization by birds, at least the diurnal ones.

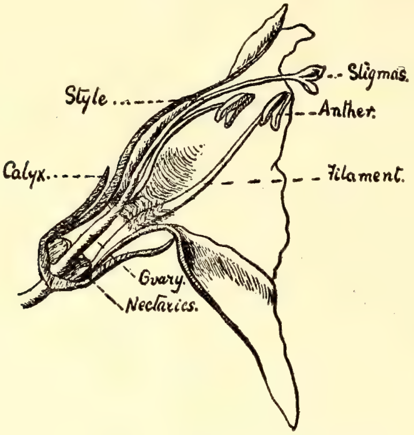


FIG. 2. Longitudinal section of the flower of *Kigelia pinnata*. (Half nat. size).

The nectar is produced in such large quantities that one literally gets a shower bath when plucking an inflorescence since, as has already been mentioned, it trickles freely into the furrows of the lower petal when the flower is bent down.

There are two avenues planted entirely with *Kigelia pinnata* trees not far from where I reside, in Gell Street and Club Back Road (Agripada). In the flowering season, March-July[1] I frequently visited these roadside trees at different times of the day and night to study more about the fertilization of their flowers. I noticed that at dusk the avenues were regularly visited by numbers of the Short-nosed Fruit Bat (*Cynopterus sphinx*) and was not a little surprised to discover that these animals were really responsible for the fertilization of the flowers. On several occasions I observed the bats visiting the open flowers, thrusting their heads into them and after hanging there a short while, flying off again. The bats are no doubt apprised of the open flowers by the strong smell they emit, as they were seen to circle round and round the trees before alighting. When the bat alights, the flower stalk, which is sharply bent upwards in its upper quarter, is deflexed by the weight of the animal and at the same time the peduncle of the flower swings, causing the nectar to ooze out on to the petal from where it is greedily licked up by the bat. In all probability at the time of the bat's impact with the flower the ripe pollen is shed on to the head of the bat as it is being inserted within, though there is also another possibility in that the head or ears of the visitor may actually come in contact with the anthers. There is yet the further possibility that as the bat throws its head back when taking to flight (as is its habit) the snout may come in contact with the anthers. Whatever be the exact manner in which the pollen is transferred to the fur, I think there is good ground for assuming that the head or snout of the bat or both, does get covered with pollen. When the bat's head is inside the flower the stigmas protrude over and directly behind it and in a position where the pollen-besmeared snout or crown must unavoidably brush past them when the animal takes to wing again, thus effecting pollenization. Assuming that the bat has been visiting other flowers previously and that its head has become covered with the pollen from these, there are two possible ways in which it may be transferred to the stigmas: (*a*) while entering the flower the head may come in contact with the stigmas, or (*b*) the impact and weight of the alighting bat which causes the flower to sway violently up and down may bring the stigmas into contact with the bat's head. Both these possibilities may indeed even operate simultaneously, but there seems to me no doubt that this bat is in a large measure responsible for the fertilization of the flowers of this tree. I realize that for conclusive

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[1] I have seen flowers and buds on certain trees as late as the end of August and early September.

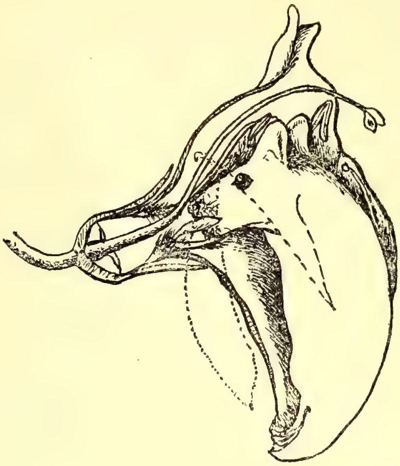

FIG. 3. Position of bat in flower. (*Drawn from memory*).

evidence it would be necessary to shoot the visiting bats for examination, but unfortunately in the present case I am unable to do so owing to the proximity of dwelling houses and the Police Regulations.

My thanks are due to my friend Mr. Salim Ali for reading over this note and drawing my attention to two important papers by Dr. Otto Porsch of Vienna[1] who has in recent years made some most valuable contributions to our knowledge on the subject of the fertilization of flowers by birds and mammals.

According to Porsch, Hubert Winkler was the first to point out from the shape and size and other peculiarities of the flowers of a closely related species, *Kigelia africana,* Benth. that this may be of bat-fertilized species although he was unable to record the visits of bats by direct observation. Porsch's own observations on *K. pinnata,* DC., in the Buitenzorg Gardens, Java, convinced him that the flowers of this tree were fertilized by bats. In regard to another closely allied species, *Kigelia æthiopica,* Decne., Porsch was also struck by the nocturnal habit of the flowers, their characteristic smell, their unusual colours and the width of the opening of the corolla. The fallen flowers under the tree showed the tooth-marks of bats and the fact that the flowers could be available to birds only for a very short time in the early morning hours, precluded the possibility of their (birds) being important pollinating agents.

Heide, who also made observations on *K. æthiopica* in the Dutch East Indies, was of opinion that the bat *Eonycteris spelaea* Dobs. which was the pollinating agent he observed, was attracted to the flowers solely by the pollen which it gathered from the anthers by means of its specially adapted rasp-like tongue. On the tongue and snout as well as inside the stomach and intestines of a specimen he shot, were found only pollen without any traces of petals or other parts of the flowers. He makes no mention whatsoever of nectar being sought, but as Porsch points out, if pollen was the bat's sole quest it is unintelligible why the visitor should thrust its head so deep down into the flowers, as has also been observed by me, and he himself is inclined to the belief that nectar is the bat's main objective.

L. V. D. Pijil, without being aware of Heide's work has independently corroborated the latter's observations in regard to the visits of bats to the flowers of *K. æthiopica.* This observer also refers to the nocturnal habit of the flowers and to their characteristic smell, but according to him likewise the chief object of the bats' visits is the pollen though he admits that at the same time nectar may be eaten.

Spennemann has observed that carrion-smelling flowers of *Oroxylum indicum* (L.) Vent. to be visited and fertilized by bats, and my note helps to confirm his remark that the flowers open in the evening and drop off the next morning. Finally Porsch has recently described from Costa Rica the flowers of *Crescentia cujete,* L. and *Crescentia alata,* H.B.K. (Order *Bignoniaceæ*) to be visited by bats, and by a careful study of their structure and physiological peculiarities he arrives at the conclusion that they are undoubted bat-flowers. Already in 1922 his investigations in tropical countries had convinced him of the existence of purely bat-fertilized flowers.

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[1] Porsch, Otto. 'Blütenstände als Vogelblumen', Österreichische botanische Zeitschrift, 1923, Nr. 6-8, pp. 125-149.

[2] Porsch, Otto. '*Crescentia*—eine Fledermausblume', Öst. bot. Zeitschrift, Heft 1, Jahrg. 80, pp. 31-44.

This opens up a vast field for observations in India, and I hope my note will induce other observers to take up the study of bat-fertilized flowers.

Bombay Natural History Society,
6 Apollo Street,
Bombay.
23-7-1931.

C. McCANN,
F.L.S.,
Assistant Curator.

XXIX.—OCCURRENCE OF *ISOËTES* IN THE BOMBAY PRESIDENCY.

Roxburgh in his *Flora Indica,* Vol. III, page 745, (1832), records two species of *Isoëtes* from India, viz. *I. capsularis,* Roxb. and *I. coromandeliana,* Linn. But so far as our knowledge goes none have been reported from the Bombay Presidency. On the 3rd September I discovered a species of this genus in rocky pools at Khandala (W. Ghats). This specimen is different from those described in the *Flora Indica* and is in all probability a new species. In a subsequent issue of the *Journal* I hope to be able to publish the full description of the plant. This constitutes the first record of the *Isoëtaceae* in the Presidency.

Bombay Natural History Society,
Bombay.
September 15, 1931.

C. McCANN,
F.L.S.,
Assistant Curator.

PROCEEDINGS OF THE MEETING OF THE BOMBAY NATURAL HISTORY SOCIETY.

A meeting of members of the Bombay Natural History Society and their friends was held at the Prince of Wales' Museum on Wednesday, the 15th July 1931, at 6 p.m. Col. Sir Frank Connor, D.S.O., I.M.S., presiding.

The Honorary Secretary Mr. P. M. D. Sanderson announced the election of the following 14 new members since the last meeting held on 30th March 1931:—

The President, Mess Committee, 1st North Staffordshire Regiment, Nasirabad; Dr. V. R. Khanolkar, B.SC., M.D., Bombay; The Conservator of Forests, Cochin State, South India; Mr. W. J. L. Smith, Palaw, Burma; Mrs. A. J. Wadia, Bombay; The Mess President, 2nd Lancers, Meerut; Mr. F. J. Guthrie-Smith, I.C.S., Meerut; The Director, Transvaal Museum, Pretoria; Captain D. L. Duncan, Loralai, Baluchistan; Mr. L. E. Hunt, Calcutta; Mr. Framji Dessabhoy Wadia, Poona; Lt. R. F. H. Drake-Brockman, B.A., Bangalore; Captain G. W. McCarthy, Agra; His Highness Maharaja Shri Himmat Singhji Saheb Bahadur, Idar State (Life Member).

Mr. P. M. D. Sanderson referred to the recent publication by the Society of Captain Bates' book on *Bird Life in India*. The author is well known to readers of the Society's Journal. His illustrated articles on Indian Birds and their Nests have formed an attractive feature of its pages. To his ability with the camera Captain Bates adds the gift of close and patient observation. His notes and pictures of Indian Bird Life make up a charming and readable book, which will appeal to all who are familiar or wish to be familiar with the birds of this country.

The Honorary Secretary announced the forthcoming publication of a second edition of Brigadier Evans' *Identification of Indian Butterflies*. The first edition, which was issued 3 years ago, sold out very quickly. Since then there have been frequent enquiries for the book which, with its hundreds of illustrations of Indian Butterflies and its simple keys, is an invaluable guide to collectors and to people interested in this subject. The second edition has been revised and enlarged should have as ready a demand as the author's previous book.

BIRD COLLECTING IN THE HIGH ALTITUDES OF SIKKIM.

In the spring of this year the Society co-operated with the Field Museum of Chicago and the British Museum in a collecting expedition in Sikkim. Mr. V. S. LaPersonne, Assistant Curator, was sent to help Mr. Stevens, the leader of the expedition in this work. Mr. Stevens was compelled to return to England shortly after LaPersonne joined him and Mr. LaPersonne continued alone. A base camp was established at 16,000 ft. in Northern Sikkim and from this point excursions were made to 19,000 ft. on to the highlands of Tibet. Mr. LaPersonne has brought back a remarkable collection from this cold, bleak region and from the dense tropical forests of the lower altitudes of the Eastern Himalayas. Some of the specimens obtained were on view to members. They included two species of Marmots, the Tibetan Hare and examples of such birds as Grandalas, Choughs, Snow Pigeons and Accentors which live in these high altitudes. Among the exhibits were four magnificent wild dogs shot at an altitude of 10,000 ft. where they prey mainly on sheep and ponies.

A New Exhibit at the Museum.

Mr. S. H. Prater, the Society's Curator, invited the members and their friends to a private view of the new group in the Mammal Gallery of the Museum and which will be shortly opened to the public. The group is a representation of a pair of tigers drinking at a forest stream. The scene is laid in the dense rain-swept forests of the Naga Hills in Assam, where the material and accessories of the group were collected during an expedition undertaken in conjunction with the American Museum of Natural History, New York, last year. The background depicting the dense forest, painted from studies made in the field by Mr. K. B. Sawardekar, the canopy of feathery bamboos, the moss covered boulders of the stream, the beautiful lighting effect provide a magnificent and realistic setting for the tigers. These were mounted by Mr. C. McCann and represent fine examples of the high development of modern taxidermy. The group makes a wonderful addition to the Museum and is one of which the people of this city may well be proud.

Persian, African and Indian Lions in the First Century.

Dr. Sir Jivanji Modi then read his interesting paper on Indian, Persian and African Lions in the First Century. The following is a brief outline of Sir Jivanji's notes:—

The subject of the paper is suggested by an interesting paper on 'The Lions of Asia' by Mr. R. I. Pocock, in a recent issue of the *Journal of the Natural History Society*. The present paper was divided into two parts. (1) The Lions from an old Iranian point of view. (2) Appolonius of Tyana, a Greek ascetic, on the Lions of Persia, Africa and India.

Lions do not seem to have flourished towards Bacteria (Balkh) where the Parsi Avesta Scriptures were written, but they flourished in the Western part of the Iranian Empire where some Pahlavi literature was written. The Pahlavi books agree with Mr. Pocock in associating the Lions, Panthers and Tigers in one genus, the genus of 'the Great Cats'. The Iranian word for Lion viz. *'Shir'* seems to come from khshathra 'King'. A Lion is the King of the Animal world.

Appolonius of Tyana, a Greek ascetic of the Indian *Sadhu* type, who abstained from animal food, wine and women and who observed total silence occasionally for days together, and believed in metampsychosis had travelled a good deal in the Iran of Parsi Mobeds and India of Hindu Brahmins; and in the account of his travels we find an interesting account of the Lions of Persia, Africa and India. In that account we find the following particulars:—

(*a*) The normal period of gestation is six months.

(*b*) Each lioness had only three litters in her life, having 3 cubs in the first litter, 2 in the second, and 1 in the third.

Appolonius saw an extraordinary lioness with 8 cubs.

(*c*) They took predictions from lions.

(*d*) The Iranian Kings had their preserves of lions at Babylon, where they hunted with beaters.

(*e*) The souls of kings e.g. King Amasis of Egypt, metamorphosed into lions who were royal beasts

(*f*) In one part of India, the apes helped men in collecting pepper from mountain cliffs. There men killed lions in great numbers because these lions killed the apes who helped them.

(g) Lionesses in some parts of India mated with tigers and gave birth to spotted cubs which the lions killed at first sight taking them to be 'bastards'.

(*h*) Indians ate the flesh of lions.

The full text of the Paper will be published in the next issue of the *Journal.*

An interesting discussion arose from Sir Jivanji's reference to apes (described as being black in colour) helping men in collecting pepper from the mountain cliffs. It was suggested by Mr. Prater that the statement may throw some light on the more southerly range of the lion in India than now recorded. Pepper is confined to the South-Indian Forests, where also live two species of monkeys, which are uniformly black in colouring and answer to the description of the writer. It is a fact that the aboriginal hill-tribe of Mysore—the Sholagas—have a name for the Lion. They call it "Simba" which curiously enough is the Swahili name for the lion.

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